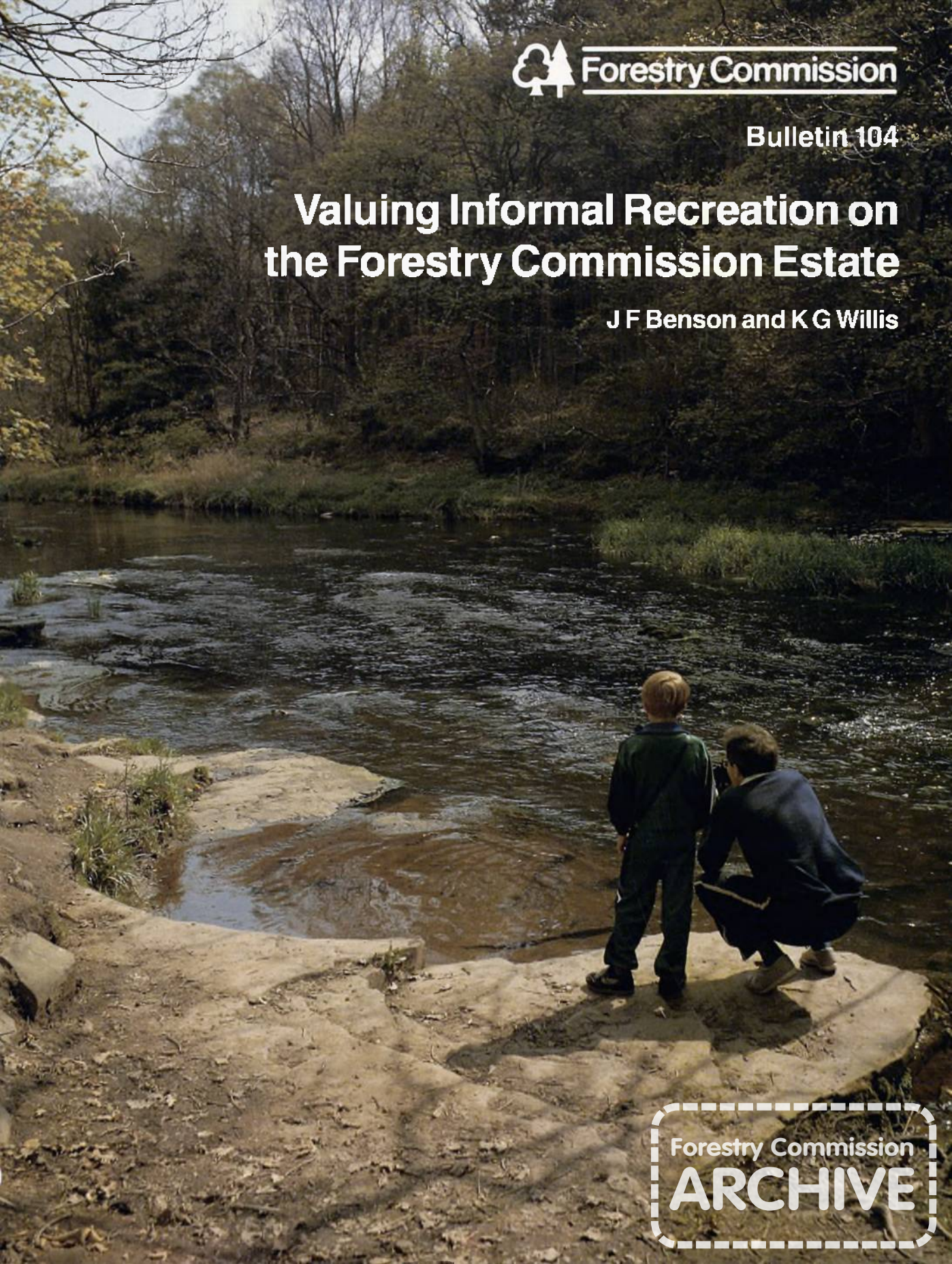

Forestry Commission

Bulletin 104

Valuing Informal Recreation on the Forestry Commission Estate

J F Benson and K G Willis

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Valuing Informal Recreation on the Forestry Commission Estate

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Front cover: Chopwell Wood, Tyne and Wear, managed by the Forestry Commission as an amenity woodland for over 70 years. A popular recreational area for day visitors from nearby Newcastle upon Tyne. *(40089)*

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Valuing Informal Recreation on the Forestry Commission Estate

Summary

The Bulletin estimates the consumer surplus (or net monetary benefit) from informal recreation on the Forestry Commission estate.

The Forestry Commission's estate of more than 1 million hectares is managed for mutiple-use and multiple benefits. Calculations of the costs and benefits of timber production are made in financial terms using discounted cash flow models. Most of the other uses and benefits, whether informal recreation, wildlife and landscape conservation, carbon fixing or job creation in rural areas, cannot easily be evaluated in this way, either because no markets exist or because many of the benefits are 'public' goods. However, techniques do exist for estimating the benefits of such uses and resources in monetary terms, and these are described.

A cluster analysis was used to select a representative sample of 14 Forest Districts in which recreational visitor surveys were made. Calculations of consumer surplus were based on a travel cost method of valuation. The average consumer surplus per visit is £2 at 1988 prices. The sensitivity of this result to different assumptions is examined and compared with the limited number of previous studies in Great Britain. Various estimates of visitor numbers, by Forest District and in total, are reviewed. The figures are combined to estimate a total value of £53 million per year (1988 prices) for non-priced informal recreation on the Forestry Commission estate in Great Britain. The average is £47 per hectare but with a very wide variation between the extremes £1 per hectare in remote areas to over £400 per hectare in exceptional cases such as the New Forest, related to accessibility and other factors.

The total benefit exceeds the estimate of £10 million quoted by the National Audit Office in 1986.

Évaluation de la Récréation sur le Domaine de la Commission Forestière

Résumé

Le Bulletin évalue 'le surplus du consommateur' (ou le bénéfice monétaire net) à partir de la récréation sur le domaine de la Commission Forestière.

Le domaine de la Commission Forestière qui comprend plus d'un million d'hectares est géré à des fins multiples et des bénéfices multiples. Les calculs des coûts et bénéfices de la production de bois sont effectués en termes financiers d'après les modèles du cash-flow actualisé. La plupart des autres services et avantages, qu'il s'agisse de la récréation, de la protection de la faune et la flore et du paysage, de la fixation du carbone ou de la création d'emplois en zones rurales, ne peuvent pas être facilement évalués de cette façon-là, soit parce que les marchés n'existent pas, soit parce que l'ensemble des avantages qui en résulte est de l'ordre des biens 'publiques'. Cependant, il existe des techniques qui permettent d'estimer les bénéfices de tels services et ressources en termes monétaires, comme décrit ci-après.

On établit une analyse en grappes pour sélectionner un échantillon représentatif de 14 districts forestiers où l'on effectua des études sur les usagers. On calcula l'excédent (le surplus) à partir d'une méthode d'évaluation basée sur le coût du voyage. L'excédent moyen par visite s'élève à 2 Livres Sterling selon les tarifs de 1988. La fiabilité de ce résultat obtenu au vu de différentes hypothèses est examinée et comparée au nombre limité d'études précédemment effectuées en Grande-Bretagne. Les diverses estimations concernant le nombre de visiteurs pour chaque district forestier et pour la totalité d'entre eux sont ainsi mises à jour. Les chiffres représentent une estimation d'un montant total de 53 millions de Livres Sterling par an (tarifs de 1988) pour la récréation non payante sur le domaine de la Commission Forestière en Grande-Bretagne. La moyenne s'élève à 47 Livres Sterling par hectare mais avec une variation très grande entre les extrêmes allant de 1 Livre Sterling par hectare dans les endroits les plus reculés à plus de 400 Livres Sterling par hectare dans les cas exceptionnels comme New Forest, en fonction de l'accessibilité et d'autres facteurs.

Le bénéfice total dépasse les 10 millions de Livres Sterling estimés par l'Office National de l'Audit en 1986.

Der Wert der informellen Freizeitgestaltung auf dem Land der Forstverwaltung

Zusammenfassung

Der Bericht schätzt den 'Verbrauchergewinn' (oder finanziellen Nettonutzen) der informellen Freizeitgestaltung auf dem Land der Forstverwaltung ein.

Das mehr als 1 Million Hektar große Gelände der Forstverwaltung wird zu vielen Zwecken und Nutzen bewirtschaftet. Berechnungen der Kosten und Nutzen der Holzproduktion erfolgen finanziell nach Gegenwartswertmethoden. Die meisten der anderen Zwecke und Vorteile, ob nun zur Erholung, Erhaltung der Tierwelt und Landschaft, Kohlenstoff-Fixierung oder Schaffung von Arbeitsplätzen in ländlichen Gebieten, können nicht einfach auf diese Weise bewertet werden, entweder weil keine Märkte vorhanden sind oder weil viele dieser Nutzen 'öffentliche' Güter sind. Es bestehen jedoch Methoden zur finanziellen Schätzung solcher Zwecke und Ressourcen, und diese werden beschrieben.

Eine Clusteranalyse wurde zur Wahl eines repräsentativen Musters von 14 Forstgebieten verwendet, in denen Untersuchungen über Besucher, die Erholung Suchten, angefertigt wurden. Berechnungen der Verbrauchergewinne basierten sich auf einer Reisekosten-Bewertungsmethode. Der durchschnittliche Verbrauchergewinn pro Besuch ist £2 zu 1988 geltenden Preisen. Die Empfindlichkeit dieses Ergebnisses gegenüber verschiedenen Annahmen wird untersucht und mit der beschränkten Anzahl von früheren Untersuchungen in Großbritannien verglichen. Verschiedene Schätzungen von Besucherzahlen pro Forstgebiet und die Gesamtzahlen werden erneut überarbeitet. Die kombinierten Zahlen führen zur Schätzung eines Gesamtwerts von £53 Millionen pro Jahr (Preise von 1988) für die kostenlose, individuelle Freizeitgestaltung auf dem Land der Forstverwaltung in Großbritannien. Der Durchschnitt ist £47 pro ha, aber mit einer großen Variation zwischen den Extremen £1 pro ha in abgelegenen Gebieten, und £400 pro ha in Ausnahmefällen wie dem New Forest, im Hinblick auf Zugänglichkeit und andere Faktoren.

Der Gesamtnutzen überschreitet die vom National Audit Office 1986 geschätzten £10 Millionen.

Chapter 1
Introduction

Background

The multiple use of forests has been a central policy of the Forestry Commission for many years. National forests are places for recreation of many kinds, as well as habitats for a diverse range of wildlife species, and an important factor in the character of rural landscapes. The problem in weighing the relative costs and benefits of such multiple objectives and uses is that no markets exist by which one might value the outputs of informal recreation, wildlife and enjoyment of the fine views to be found in forests. Visitors do not in general pay an entrance fee, but they (and non-visitors) do pay indirectly through taxation and public subsidies to Forestry Commission investments in recreational facilities; also, modifications to planting and harvesting strategies undertaken in the interests of 'environment' reduce the financial profitability of some forests. The Forestry Commission must seek the most valuable balance between its multiple, and to some extent conflicting, objectives.

One approach is to try to value the environmental costs and benefits in units that will allow a direct comparison with timber production. The obvious common unit is money, and environmental economics involves a variety of approaches by which money values can be placed upon environmental goods. This Bulletin describes a monetary calculation of the use-value for informal recreation of the Forestry Commission's forests.

Evaluation of forest recreation

The Land Use Study Group (LUSG, 1966) report concluded that the national net discounted revenue to forestry exceeded that to agriculture only on poorer land and where the discount rate was below 3–4%, but recognised the sensitivity of that conclusion to small changes in cost and price; it only acknowledged recreation, wildlife and amenity benefits of forests in qualitative terms.

The first major evaluation of forest recreation was the HM Treasury (1972) cost–benefit study. The main body of the report dealt with Forestry Commission forests and conducted its valuations at three different levels, using commercial costs and revenues, resource costs, and resource costs after the Forestry Commission had adjusted to a more efficient management regime. The study also broke new ground in extending the scope of valuation of benefits to include recreation and amenity and in applying a 10% discount rate. The attempt to value recreation depended on one (unpublished) estimate of consumer surplus per recreation day which was used as a basis for valuing different lengths of recreational experience, calculating national aggregate values from these and projecting them forward over the unfolding national forest rotations. The effect of using a 10% discount rate was to produce substantial negative net present values under most circumstances. Nevertheless the inclusion of recreational benefits did reduce these losses to an important extent. This is particularly important under high discount rates since recreation benefits appear earlier in the forest rotation than sales of timber and are therefore discounted less heavily. This can be seen from a simple example in Table 1.1, where a 10% discount rate reduces the timber benefits to less than those for recreation, whereas at 5%, timber revenues are more than twice those of

Table 1.1 The impact of discounting on the relative values of timber and recreation, expressed as net present value in £ ha^{-1}.

	Discount rate (%)		
	0	*5*	*10*
Timber value: clear felling in year 50	10 000	872.04	85.14
Recreation value: £50 per annum, years 15–50	1750	393.81	115.44

recreation benefits.

The current policy debate on forestry stems in part from two more recent reports: one from the National Audit Office (NAO, 1986) and a discussion of that report by the Public Accounts Committee (PAC, 1987). The NAO Report refers to an estimated 'consumer surplus' of £10 million yr^{-1} for non-priced informal forest recreation, which would give a capitalised value for the whole estate of £200 million. It is believed that this estimate comes from the forward extrapolation of the 1972 HM Treasury cost–benefit study. The PAC considered the NAO report and published its own conclusions:

> "Other factors which have been advanced to justify acceptance of low rates of return from forestry include the recreational value derived from public enjoyment of forests and the beneficial effects on the environment. Although we recognise that investment in forestry has some beneficial impact in such matters, it is by no means certain whether or not all of the consequences are positive or what weight should be attached to them."

The PAC recommended that:

> "Generally . . . across many of the Commission's activities there was insufficient assurance on the extent and quantification of the benefits achieved or how far these were commensurate with the resources used to achieve them. We are concerned that there appears to have been no fundamental re-examination since 1972 of the information needed and available to support many of the policy and operational decisions being made.
>
> We emphasise the importance of tackling the problems involved in improving the quantity and quality of necessary information, not least because of the likelihood of Government subsidies for the Forestry Commission being continued until well into the next century."

The present study

While there is a frequently quoted general view that forest recreation and the environment are important, there has been very little effort directed at producing quantitative evaluations of such matters.

The present study therefore seeks to estimate the use-value of different types of forest to visitors and assess the total recreational use-value of the Forestry Commission's forests.

The Bulletin is organised as follows: Chapter 2 reviews different definitions and concepts of value, while Chapter 3 reviews the valuation methods available for non-marketed benefits. Chapter 4 outlines the theoretical background to the travel cost method, the technique used in the present study. Chapter 5 describes the way the estate was classified for sampling, and Chapter 6 describes visitors surveys carried out in Forest Districts. Chapter 7 describes the results from the travel cost method and estimates the consumer surplus (or net benefit) for each visitor. Chapter 8 reviews data on the number of visitors to the estate, and Chapter 9 combines the data to produce an aggregate estimate for the overall use-benefits from informal recreation. Finally, Chapter 10 discusses and summarises the results.

Chapter 2

Concepts of Value

Financial value

A primary purpose of the Forestry Commission and private forestry is to produce timber. Since prices exist for all types of timber from forests, this output of forestry can be valued.

The Forestry Commission use discounted cash flow (DCF) models for different types of forest rotation. These vary by tree type, spacing, and yield class. The yield class is the maximum mean annual increment (in m^3 of wood volume ha^{-1} yr^{-1}) that a stand of trees can achieve and varies, for example, with soil type and climate. Windthrow risk – the degree of exposure to high winds and hence probable damage to the crop – means that in many parts of upland Britain trees must be felled before their optimal rotation age.

DCF models incorporate such costs as ploughing and draining, fencing, planting, fertilising, weeding, protection and road construction. Revenues can accrue from thinning during the rotation, but arise mainly from felling at the end.

These revenues and costs can be discounted to produce a net present value (NPV) (Price, 1989):

$$\text{NPV} = \sum_{t=0}^{T} B_t(1+i)^{-t} - \sum_{t=0}^{T} C_t(1+i)^{-t}$$

where

B_t = timber revenues from sales in year t
C_t = costs incurred in timber production in year t
T = length of timber rotation
i = interest rate or public-sector test discount rate

Considerable debate exists over the appropriate rate of discount and this largely determines the value and profitability of a project which has a length of life as long as forestry. The public-sector test discount rate for investment appraisal was set at 5% from 1978 to 1989 and was raised to 6% in 1989. The Forestry Commission, however, has only to meet a target rate of return of 3%; this reflects a decision to provide an element of subsidy for such goals as employment creation and recreation provision.

The internal rate of return (IRR) is calculated as a discount rate which equates the present value of both benefits and costs in a net present value calculation, i.e. a discount rate which gives a NPV = 0. IRRs in Britain, based on timber value alone, seldom reach 6% and for slow-growing broadleaved species may be very small indeed.

Economic value

Market prices are explicitly used to measure the costs and benefits of the timber production output of forestry. However, there are exceptions to this general rule and they arise when timber production interacts with factors where prices are implicit in exchanges: where timber production involves market imperfections, unemployed resources, and where public goods and intangibles exist.

One such factor is the demand for forest recreation. While individuals do not freely choose the level of this environmental 'good', they may in effect make market purchases in order to use it. Thus, for example, costs may be incurred to visit a forest recreation site. Economists have developed two groups of techniques to overcome the valuation of 'public goods', and these are described in Chapter 3.

Public good values can be broadly divided into use and non-use values. Use values are associated with actual consumption of a good, such as recreational visits to forests, and these form the focus of this Bulletin. However, it is probable that non-use values might be large and significant for forests. Non-use values are economic values that people place on a good even though they have no intention of using it. Non-use values comprise option, existence, and bequest values.

Non-use values

Option value is associated with the concept of risk aversion, and the premium to keep open the option of future demand until the individual's uncertainty about their demand is resolved. Empirical studies of wildlife in the USA, for example, have revealed option values almost as large as consumer surplus.

Existence value is the value individuals derive from knowing a forest or a particular type of forest exists, even if they personally have no intention of visiting it. Environmental protection measures receive strong voter support even among individuals and in areas unaffected by the proposals, while existence values are also expressed in the market place by voluntary contributions paid by members to environmental groups and by time spent by environmental activists. Existence value is likely to vary by type of forest.

Areas such as the New Forest are also the subject of stewardship by the Forestry Commission and other public bodies. Bequest values are linked with stewardship and exist when an individual enjoys knowing that the current provisions of an amenity will be available for others or future generations to enjoy.

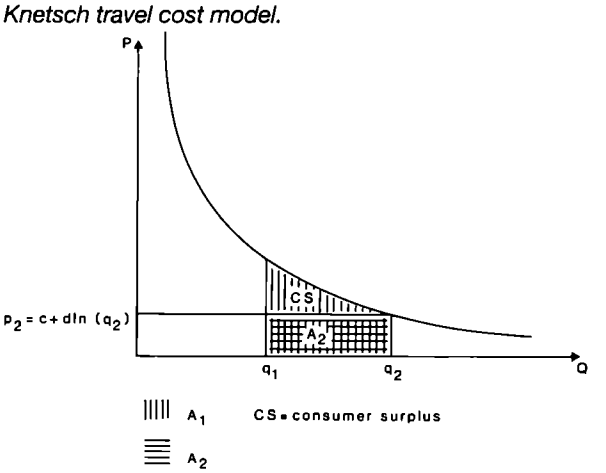
Willingness-to-pay and consumer surplus

Economists measure value by willingness-to-pay (WTP) either in terms of actual expenditure or expressed intention to pay. The latter case is often elicited by contingent valuation techniques (discussed in Chapter 3) and requires a belief on the part of the investigator that the respondent will actually pay when requested to do so at some future date.

Actual expenditure is recorded by the demand curve for recreation at a particular site, which measures WTP and the quantity demanded at any given price (Figure 2.1). The demand curve is also the marginal utility curve (of either the individual or society depending upon whether an individual or aggregate demand curve is being constructed). Measuring demand is therefore extremely important in valuing recreational benefits.

Benefits can be measured in financial terms as the price charged (e.g. an entrance fee and/or the cost of travelling to the site) multiplied by the quantity (the number of visitors). However, total utility exceeds financial payment by the amount of consumer surplus (Figure 2.1). Indeed, if the cost of resources employed to reach the recreation site equals the travel cost to get there, then the net benefits attributable to the site are by way of consumer surplus alone. Methods to estimate consumer surplus are outlined in Chapter 3.

Figure 2.1 *Consumer surplus derived via a Clawson–Knetsch travel cost model.*



Note: As P (price of trip) increases, the quantity Q (measured as trips per capita) declines. For any given zone, say q_2–q_1, where the cost of the trip equals p_2, area A_2 represents the cost of the trip (travel plus time costs) and CS represents the consumer surplus on visits from this zone.

Alternatively, the whole area under the demand curve for any zone, q_2–q_1, can be viewed as a measure of the benefits from the recreational experience; and the area A_2, i.e. $(q_2–q_1) \times p_2$, as the opportunity cost of the visit.

Chapter 3

Valuation Methods

Introduction

There are two basic approaches to valuing recreational and other environmental benefits. 'Market related approaches' are based on linkages between non-priced recreation and markets for related private goods and services. 'Expressed preference approaches' are based on personal surveys which ask people about values they would place on assets if ideal markets did exist, or if other means of payment such as taxes were in effect. In market related approaches hedonic pricing and travel cost methods dominate, while under expressed preference approaches, contingent valuation techniques are widely employed.

Hedonic price methods (HPM)

HPM can be used to value certain types of assets by linking wages or house prices to environmental attributes. They seek to assess the differential premium on property value derived from proximity to some environmental attribute. They do this by standardising for all other variables such as plot size, number of bedrooms, number of bathrooms, garage spaces, central heating, etc., which can affect house values, so that the net contribution of the environmental factor can be determined.

The HPM approach has been used to value forestry in the USA by determining whether or not trees contribute to residential property values (e.g. Payne and Strom, 1975). One study in Amherst, Massachusetts estimated that good tree cover added 6% to the total property value. Another study of sales of single family properties in Athens, Georgia (Anderson and Cordell, 1988) indicated that landscaping with trees was associated with a 3.5% to 4.5% increase in sales prices.

In judging the potential use of HPM for valuing forest recreation in Britain, three issues must be considered. First, is the link between forest recreation use and the corresponding environmental attribute (e.g. frequency of use, type of recreation, tree species mix, etc.), firmly established in the minds of property owners? Second, is nearness to forests likely to be valued by buyers and sellers of houses? Finally, are there enough cases of sales of houses near forests to use the technique? It seems doubtful that forest recreation imposes such an impact on a household's budget in relation to other expenditures that households make a conscious effort to live near a forest to specifically enjoy forest recreation *per se*. Moreover, there is a dearth of housing around most forests, and considerable difficulties can be encountered in obtaining information on housing characteristics and sale prices. The technique is therefore unlikely to be useful for this purpose.

Travel cost methods (TCM)

The travel cost method (TCM) avoids many of the problems associated with the HPM in relation to forestry in Britain. This uses expenditure incurred by households or individuals to reach a site as a means of measuring willingness-to-pay for the recreational activity. In this way the TCM uses trip expenditures as a proxy for market prices in demand estimation. It is possible to value the whole of the recreational area of the forest in this way.

The TCM has been widely applied to valuing outdoor recreation facilities such as lakes and

reservoirs (Mansfield, 1971; Gibson, 1974) and fishing sites (Lewis and Whitby, 1972; Loomis, Sorg and Donnelly, 1986). A few TCM valuations have been undertaken of forests in Britain. Some early empirical work was undertaken by Grayson, Sidaway and Thompson (1975). Everett (1979) attempted to place a value on wildlife as part of forest recreation using the TCM.

Contingent valuation techniques (CVT)

It has been argued that contingent valuation techniques (CVTs) represent one of the most promising approaches yet developed to measure people's willingness-to-pay (WTP) for 'public goods'. CVTs use questions to elicit people's preferences for public goods and their WTP for increases in (or to avoid decreases in) public good quantities and qualities. It circumvents the absence of markets or the need to seek and infer values from related private markets, by presenting consumers with hypothetical markets in which they have the opportunity to buy the goods in question. CVTs can be conducted by mail surveys, but the personal interview is much more common and probably produces much more reliable and 'true' WTP responses. A CVT study consists of (1) a detailed description of the goods being valued and the hypothetical circumstances under which it is made available to respondents and (2) questions which elicit the resondent's WTP for the goods being valued.

CVTs have been widely used to value recreation, mainly in the USA. For example, Davis (1963) interviewed hunters and visitors to the Maine woods to estimate their WTP for recreation; Hammack and Brown (1974) mailed a questionnaire to hunters to determine their WTP to acquire and willingness-to-accept compensation (WTA) to give up their rights to hunt waterfowl; Cicchetti and Smith (1976) asked hikers in a wilderness area how much they would be WTP to reduce congestion from other hikers.

Because CVTs use surveys to obtain consumer responses to hypothetical situations, this makes it vulnerable to various types of errors. The chief criticisms of CVTs have centred on biases inherent in the techniques, principally strategic bias and the free rider problem, starting point bias, payment vehicle or instrument bias, hypothetical bias, mental account, information and aggregation biases.

However, if economic and statistical biases are explicitly tackled and steps taken to avoid them, CVT findings can be used with confidence. In general, if CVTs are well carried out, they appear to be as accurate as other methods. This was shown in an early study comparing CVT results with those measured by an alternative method, in this case the TCM (Knetsch and Davis, 1966). Moreover, CVTs require the researcher to make fewer assumptions, and the technique is capable of measuring benefits (e.g. option and existence values) that other methods can only measure with difficulty.

The TCM was chosen for the present study for two main reasons. First, because the emphasis of the project was on the direct use-values produced by informal recreation on the estate, and second, because this was the method used in the HM Treasury cost–benefit study in 1972 and by a number of other researchers examining informal recreation in forests in Great Britain, including Grayson, Sidaway and Thompson (1975) and Everett (1979).

Chapter 4

Travel Cost Method: Theory

The basic travel cost method

Inferring benefits or consumers' willingness to pay for non-market recreation goods was developed and applied in the 1950s by Trice and Wood (1958) and Clawson (1959). The majority of applications of the travel cost method (TCM) have involved outdoor recreation, e.g. Knetsch (1963), Clawson and Knetsch (1966), Lewis and Whitby (1972), Gibson (1974), Grayson, Sidaway and Thompson (1975), Vickerman (1975), Loomis, Sorg and Donnelly (1986) and Willis and Benson (1989b).

The TCM estimates the benefits of a non-market good by deriving a demand (marginal valuation) curve for the good (usually a site). In order to build up a marginal value schedule for an existing site, the number of trips that take place at each of a range of prices must be observed. The price paid to visit a forest is the value of what visitors must sacrifice in order to gain access to the site. This will or may be made up of visitors'

1. travel costs (private car operating costs or public transport costs);
2. entrance fee (not usually charged for forest access but may be charged for specific recreation facilities, e.g. forest drive);
3. time (the value of the opportunity visitors forgo by using their time to undertake the visit in question rather than using it in some other way).

Apart from (any) entrance fee, the sacrifice made by visitors is related to distance. It is necessary, therefore, to observe how trip numbers vary as distance from the forest varies. The area around a forest can be divided up into zones. Every visitor originating within a given zone can then reasonably be assumed to pay the same 'distance price', based on the average distance price zone dwellers would have to pay. The number of trips will vary between zones depending upon (1) distance prices (the variable whose influence is to be isolated) and (2) population numbers within each zone.

To eliminate the effects of population variation, trips generated are expressed in terms of trips per capita (zone population). Mathematically, the general form of the trip demand curve can be stated as:

$$V_i/N_i = f(TC_i)$$

where

V_i = total number of trips by residents of zone i per unit of time

N_i = population of the i zone

TC_i = cost of visiting the site from zone i.

While TC is termed the travel cost, clearly it could include such items as food and lodging.

The total benefit is represented by the area under the demand curve (based on the above equation). The net benefit, however, is the consumers' surplus: the additional utility over and above consumers' expenditure (cost) on travel to reach the site. Although expenditure incurred to reach the forest represents a benefit in the sense of willingness to pay to enjoy forest recreation, it also represents the cost of resources consumed to do so.

Mathematically, let TC^* equal the intercept of the trip demand curve. The integral of the trip demand curve between a zone's travel cost and TC^* is an estimate of consumer surplus per capita for that zone. Thus the consumer surplus for each zone (where the zone is the difference between two visit rates, q_2 and q_1) is the area under the demand curve (A_1 in Figure 2.1) minus the cost of making the visit (A_2 in Figure

2.1). Multiplying each such value by zonal population and summing across all zones gives a total consumer surplus estimate (Williams and Anderson, 1975; Willis, 1980) (see Figure 2.1):

$$\text{total consumer surplus} = \sum_{i=1}^{N} N_i \int_{TC}^{TC^*} f(TC)\, dTC$$

Alternatively, consumer surplus can be estimated by making hypothetical changes to the entry fee. This permits a demand curve to be built up and was the approach originally suggested by Clawson (1959). This predicts how rapidly trips would decline if admission fees were actually charged or increased in real terms. This prediction is estimated for people in zones with lower travel costs by examining the actual behaviour of people in more distant, higher cost zones. For example, suppose the per capita cost of a visit from zone 2 was £2.50 and the visit rate was 0.03 per capita per year; and for zone 3 the respective figures were £3.00 and 0.02. The introduction of a 50p entry fee would increase the cost of visiting the site from zone 2 to £3.00. This is assumed to reduce demand for visits from zone 2 to 0.02 per capita (based on the actual behaviour of people in zone 3 who previously experienced this price). In this way a demand curve can be built up based upon changes in visitor numbers in relation to hypothetical changes in entry fees, and consumer surplus estimated (see Willis, 1980 for an example).

Refinements to the basic travel cost method

If there are differences in preferences or incomes across zones, the simple version of the trip demand curve could lead to biased predictions. Thus, the basic model should be modified and extended to:

$$V_i/N_i = f(TC_i, Y_i, S_i)$$

where

Y_i = average income in zone i

S_i = vector of socio-economic characteristics of population of zone i

Additional modifications to the basic model, which have generated much discussion and research effort, are concerned with variation in travel time, differences in the availability of substitutes and complements across zones, and changes in environmental quality at sites.

Those living farther from the site not only have higher money costs per trip, they must also expend more time getting there. It is reasonable to assume that the travel time to and from the site has some opportunity cost either in terms of wages or an alternative leisure activity forgone. If so, the trip demand curve, as specified above, will underestimate participation rates as the (hypothetical) entry fee. To see why this occurs, assume that round-trip travel time is 2 h from zone 2 and 3 h from zone 3. When the hypothetical entry fee is increased, it will reach a point when the predicted trips per capita rate from zone 2 equals the current actual visits per capita from zone 3. This would be an underestimate since people from zone 2 have lower travel times and would come more often, other things being equal. Conversely, reducing the travel cost of visits from zone 3 to that of zone 2 would increase the number of visits. But it would almost certainly not increase to the rate of the less distant zone because people from zone 3 still need to spend more time than people in the nearer zone and many could not or would not take the time to travel to the site. Thus the simple TCM provides a biased estimate of the number of visits that will occur with an increase or decrease in travel costs; econometrically, this can be viewed as an omitted variable problem. The basic model needs to be modified to:

$$V_i/N_i = f(TC_i, T_i, Y_i, S_i)$$

where

T_i = travel time from zone i to the site

Travel costs and time are often positively correlated, which implies that the least-squares regression coefficient on TC_i in the basic model may be biased because of the problem of multicollinearity. One solution, and the one adopted in this study, is to translate travel time into monetary units and add it to TC_i.

Cesario (1976) concluded from a survey of urban transportation studies that the value of non-work time spent in travel was between one quarter and one half of the wage rate. Results

presented later in this study value time at 0%, 25% and 43% of wage rates to assess the likely magnitude of the range of results and also the sensitivity of the results to the value of time. The choice of 25% and 43% derives from Department of Transport (1987) estimates used in appraising road schemes.

Forest recreation sites usually have substitutes. If such substitutes exist and are not taken into consideration in the estimation of the demand curve, omitted variable bias will be introduced and the degree of over-estimation will depend upon the elasticity of substitution between alternative sites.

Two different approaches have been devised to deal with the site substitution problem. First, single equation gravity models account for substitutability among sites by including measures of the qualitative characteristics of sites in the trip demand equation.
Thus

$$V_{ik}/N_i = f(TC_{ik}, T_{ik}, Y_i, S_i, A_k)$$

where

V_{ik} = trips from zone i to sites k, $k = 1, \ldots K$

TC_{ik} = vector of travel costs from zone i to K sites

T_{ik} = vector of travel times from zone i to K sites

A_k = vector of attributes of the K sites

Such an equation would be estimated using data from all sites (see for example, Cesario and Knetsch, 1976).

Another approach is a multiple equation approach, which explicitly treats alternative sites that are either imperfect substitutes or complements as different products. Thus, different demand functions are estimated for the sites, with K demand equations for K sites.

$$V_{i1}/N_i = f(TC_{i1}, T_{i1}, Y_i, S_i)$$
$$V_{i2}/N_i = f(TC_{i2}, T_{i2}, Y_i, S_i)$$
$$\vdots$$
$$V_{ik}/N_i = f(TC_{ik}, T_{ik}, Y_i, S_i)$$

This was the approach adopted by Burt and Brewer (1971), Samples and Bishop (1985) and Seller, Stoll and Chavas (1985).

If accessibility to, or the quality of, a particular forest is decreased (e.g. due to an increase in TC_i, or by forest management) necessitating further travel to alternative sites, not only will fewer visits result (movement along the demand curve for the site) but some visits would be diverted to nearby sites (resulting in a shift in demand for substitute sites).

While the TCM can be used to estimate total site values, and hence all or nothing changes, in many cases afforestation or changing management practices do not destroy the site but rather lead to a change in the quality and quantity of recreational provision at an existing site. The problem then is to determine how a change will shift the aggregate demand curve (Sutherland, 1982; Vaughan and Russell, 1982; Loomis, Sorg and Donnelly, 1986), but this is beyond the scope of the present work.

Chapter 5

Classification of the Estate

Administrative structure

For administrative purposes, following the 1985 restructuring and prior to the major re-organisation in 1992, the Forestry Commission divided the country into Conservancies – three in England, three in Scotland and one in Wales – each in the charge of a Conservator of Forests supported by a staff of forest officers, land agents, engineers and other personnel. The Conservancies were divided into Forest Districts (Figure 5.1), under the control of Forest District Managers, containing forests of varying size and number. There were 67 Forest Districts during the present study.

Diversity and forest character

The Forestry Commission has responsibility for the management of more than 1 100 000 ha, making it the largest estate manager in Great Britain (Locke, 1987). About 900 000 ha are under trees or awaiting planting. The remainder of the estate includes tree nurseries, agricultural and grazing land, forest workers' houses and land which is unsuitable for planting. The land use on the estate is shown in Table 5.1. The species and age structure on the estate varies considerably, from ancient and diverse areas such as the New Forest in southern England to new plantations of low diversity in the uplands of north and west Scotland.

Provision for recreation has been made over a period of many years (Forestry Commission, 1984). Access on foot to most of the estate is possible in principle, for walking and informal recreation (notwithstanding location, deer fencing and other physical barriers), although special provisions and investments have been made for camping, caravans, picnics, walks, trails, drives, holiday cabins and other visitor attractions. Much of the special provision has been

Table 5.1 Land use on the Forestry Commission estate (000s ha).

	England	*Wales*	*Scotland*	*Great Britain*
Plantations	240.3	133.3	526.1	899.7
Awaiting planting	2.2	1.1	23.4	26.7
Total forest land	242.5	134.4	549.5	926.4
Other land	39.4	10.9	179.7	230.0
Total area	281.9	145.3	729.2	1156.4

Notes:

1. Areas as at 31 March 1987.
2. There has been a major updating of the Forestry Commission's land records during 1986–87, resulting in some re-classification of land between the various headings within each country.
3. Plantations include 10 300 ha of woodland managed chiefly for amenity purposes.
4. Other land includes nursery, agricultural and grazing land, forest workers' holdings and unplantable land.

Source: Forestry Commission.

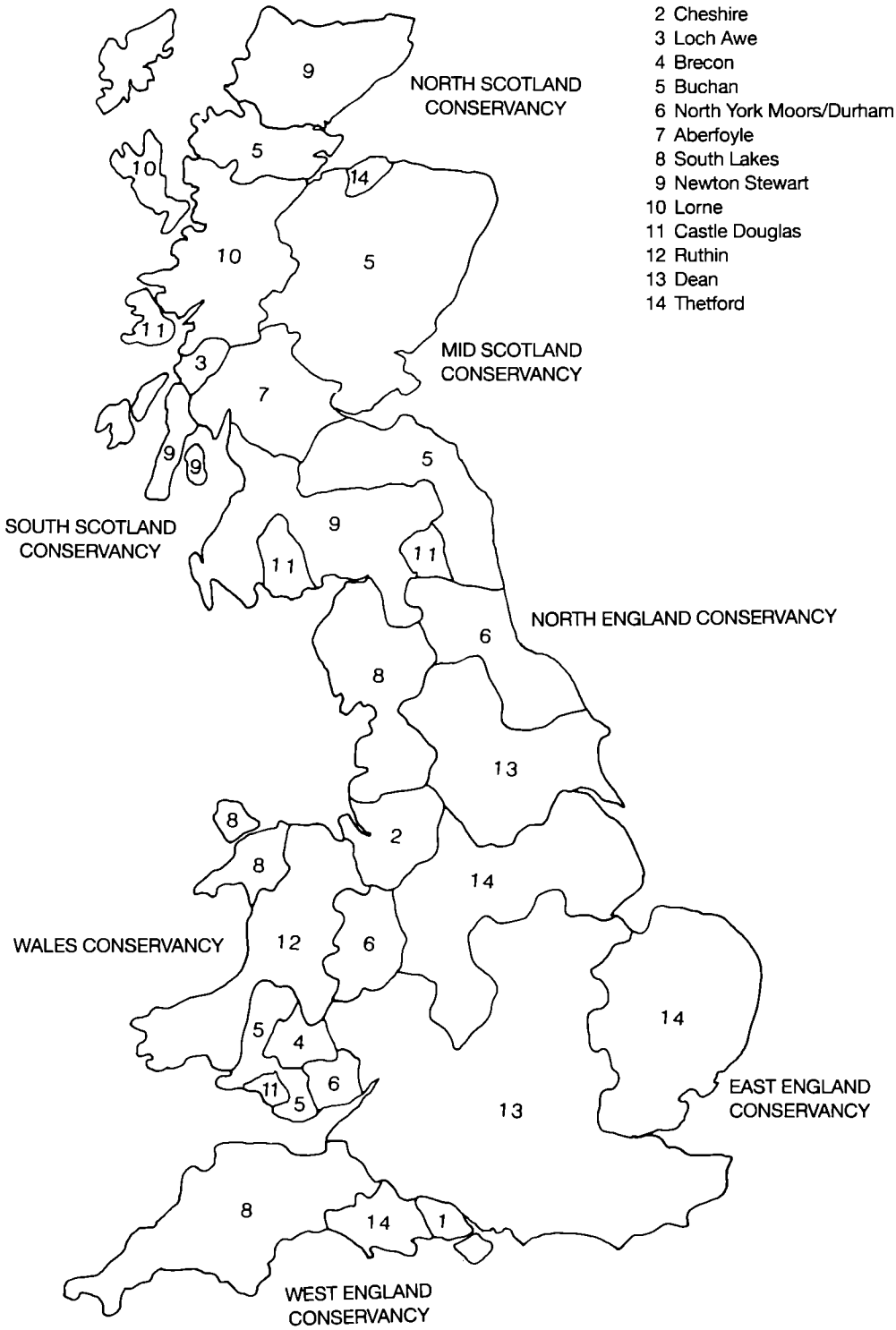


Figure 5.1 *Cluster analysis of Forest Districts.*
Districts surveyed were:

1 New
2 Cheshire
3 Loch Awe
4 Brecon
5 Buchan
6 North York Moors/Durham
7 Aberfoyle
8 South Lakes
9 Newton Stewart
10 Lorne
11 Castle Douglas
12 Ruthin
13 Dean
14 Thetford

made in a series of Forest Parks; they now number 11 and cover an area of about 180 000 ha.

Forestry Commission investment in (wildlife) conservation focuses first on more than 340 Sites of Special Scientific Interest (SSSIs) on Forestry Commission land (which include 16 forest nature reserves that have recently been established (Forestry Commission, 1989)), and second on forests and woodlands as general wildlife habitats (Forestry Commission 1982, 1986a and b, 1990; Steel, 1972). The habitats and species which exist on the estate are very diverse, and the potential conflict between timber production and certain pest species should be noted (Ratcliffe, 1987).

It is also important to note that the focus of the present study is the issue of the use-value for informal recreation of the Forestry Commission's existing estate and the results cannot be applied without qualification to the wildlife, landscape or recreational impacts and values involved in the afforestation of bare land.

Classification and sampling strategy

It was impractical, because of resource constraints, to survey visitors to all Forestry Commission forests. A sample survey was required which was representative of the estate and the non-priced recreation on that estate, so that estimates of recreational benefits could be aggregated.

From the perception of the visitor the logical 'unit' for classification is the 'forest'. However, much of the Forestry Commission's estate is fragmented and in many areas it is difficult to define a single 'forest' with precise boundaries, while in other areas the forests merge to produce very large expanses of forested land, the results being ill-defined 'forests'. Thus Forest Districts were used as the basic spatial unit upon which to undertake the analysis.

Approach

A rigorous technique was required which would handle a large data set and would systematically sort, test, refine and explain the basis for the classification. Cluster analysis was chosen as the most appropriate technique for this task.

The data set

Because the use of the estate for recreation will be influenced by (1) the physical and biological characteristics of the estate, (2) the recreational facilities provided and (3) the accessibility of the estate for people, three sets of data were assembled for each Forest District (Table 5.2).

The initial choice of variables used to describe each Forest District constitutes the frame of reference within which to establish the clusters and the results will reflect, to some extent, the judgement of the relevance of these variables for the purposes of clustering, and the number and type of variables included (Johnson, 1978).

Table 5.2 Variables used to determine representative Forest Districts

1	% broadleaves pre-1901
2	% broadleaves 1901–20
3	% broadleaves 1921–40
4	% broadleaves 1941–65
5	% broadleaves 1965 on
6	% larch, Scots pine and Corsican pine pre-1901
7	% larch, Scots pine, Corsican pine 1901–20
8	% larch, Scots pine, Corsican pine 1921–40
9	% larch, Scots pine, Corsican pine 1941–65
10	% larch, Scots pine, Corsican pine 1965 on
11	% other conifers pre-1901
12	% other conifers 1901–20
13	% other conifers 1921–40
14	% other conifers 1941–65
15	% other conifers 1965 on
16	% forest land in wind hazard class 1 + 2
17	% forest land in wind hazard class 3 + 4
18	% forest land in wind hazard class 5 + 6
19	Number of car park spaces
20	Number of forest drives
21	Number of camp person-nights
22	Number of cabin person-nights
23	Number of walks
24	Length of walks (km)
25	Number of picnic places
26	Number of specialist recreational activities
27	Population density
28	Population 000s
29	Area (000s ha)
30	Commission land (000s ha)
31	Commission land as % of total area

Source: Forestry Commission.

Cluster analysis

Cluster analysis attempts, given a set of n objects (67 Forest Districts) and observations of their qualities (variables in Table 5.2), to form them into groups on the basis of their internal similarities. However, as Kendall (1975) points out, the very concept of clustering is a subjective matter, and there is no one method of cluster analysis.

Procedure

The analysis proceeded in two stages in order to provide insight into the best ways to interpret the results.

Stage 1

Initially only physical and biological data were used and subjected to hierarchical grouping methods (Ward's method and average method of within and between group distances (SAS, 1986)), which produced identical results.

Hierarchical techniques are probably the most commonly used; agglomerative hierarchical methods successively fuse Forest Districts or clusters of Forest Districts which are closest or most similar. Differences between methods arise because of the different ways of defining 'distance', or similarity, between a Forest District and a cluster containing several Forest Districts, or between two clusters (note that 'distance' is not a geographical measure, but is a mathematical measure of the separation of Forest Districts using the recorded variables). In the case of the group average methods, the 'distance' between clusters is defined as the average 'distance' between all pairs of Forest Districts in the two clusters. Other methods define this 'distance' in other ways, e.g. as the distance between the two clusters' closest members (Everitt, 1977). It should be borne in mind that the group average and Ward's methods often find 'spherical' clusters (in a geometrical sense) even when the data appear to contain other shapes. Consequently they may impose a structure on the data rather than extract the actual structure present (Everitt and Dunn, 1983).

A major problem is deciding on a particular number of clusters which best fits the data. This was done by plotting the values of the clustering criterion, the *pseudo* t and f statistics, which indicated cluster sizes of either 2 or 12. However, there is no satisfactory statistical definition of exactly what constitutes a cluster, and formal assessment of the significance of clusters is really only an analytic problem relative to a particular definition. In practice, solutions should be judged in terms of their interpretability and the predictive ability of the results.

The interpretability of the clusters based on physical and tree data did seem to make intuitive sense and this was confirmed in discussions with the Forestry Commission.

Stage 2

Given the focus of the study on recreational use of the forests, the analysis was then expanded to include various recreational and other data. Integrating the recreation data proved problematic since some were recorded on the basis of presence or absence, whereas the forest data were of the interval variety. Cluster techniques are not suitable for a mixture of different types of measurement (nominal, ordinal and cardinal). Hence the binary data in the set (presence or absence of visitor centre, etc.) was removed.

It should also be appreciated that every variable is accorded equal weight in the classification procedure, which implies some prior decision that 'distance' between two observations on one variable has exactly the same importance as the identical 'distance' on another variable (Johnson, 1978). Thus the results are sensitive to the variables included, the number of physical and tree variables in comparison with recreation variables, and the measurement of some of the non-recreation variables on a non-ratio scale.

In order to improve the interpretability of the results with combined recreation and forest data, the data were subjected to a technique which seeks to partition the data set so as to optimise some predefined clustering criterion. This technique assumes that the number of groups into which to partition the data has been set by the user to some value k (k was set to 6, 8, 10, 12, 14 and 16 clusters on successive runs). Individual Forest Districts are then assigned to one of the groups for a given k. This method dif-

Table 5.3 Final classification of Forest Districts (and descriptions of clusters) as sampling basis for the survey of recreational visitors (see text for further explanation; surveys took place in Districts in italic).

Cluster 1: The *New* Forest
The New Forest growing stock includes a large proportion of older trees particularly broadleaves. Public use of the forest is high and many recreational facilities have been provided. Timber production is secondary to other uses of the forest.

Cluster 2: *Cheshire* Forest District
Cheshire Forest District has an above average proportion of larch, Scots pine and Corsican pine, much of which is in the older age classes. This Forest District also has a very large population within its boundaries, but a very small area of Forestry Commission land.

Cluster 3: *Loch Awe* Forest District
Loch Awe Forest District has a large proportion of young crops, mainly spruce, and high windthrow hazard classes. It differs from Cluster 9 in the high proportion of Forestry Commission land within the Forest District boundary and the presence of a forest cabin development.

Cluster 4: *Brecon* Forest District
Brecon Forest District has a high proportion of middle aged crops, mainly spruce, but without extremes of windthrow hazard class. It differs from many Welsh forest districts in being well provided with forest walks.

Cluster 5: Rothbury; *Buchan*; Llanwynno; Kincardine; Rheola; Easter Ross; Llandovery; Inverness; Speyside; Angus; Fife; Perthshire; Lothian.
This group comprises a number of forest districts largely in the eastern half of the country from north of Inverness to Northumberland plus an area in south Wales. Characteristic features include a below average amount of older broadleaves but an above average amount of non-spruce species. Windthrow hazard classes tend to be in the middle of the range.

Cluster 6: *Durham*; Marches; *North York Moors*; Gwent
Cluster six comprises four forest districts with a diversity of age classes and species including a higher than average proportion of older crops. Although not in lowland England windthrow hazard classes in these districts are not high.

Cluster 7: *Aberfoyle*; Cowal
Cluster 7 covers two forest districts with large areas of young conifers, mainly spruce. Because they are in a tourist area and close to a large centre of population (Glasgow) many recreational facilities have been provided.

Cluster 8: North Lakes; Somerset; *South Lakes*; Llanrwst; Cornwall
Cluster 8 comprises forest districts in major tourist areas with a high proportion of older conifers particularly spruce and/or Douglas fir.

Cluster 9: Border; Ayrshire; Dornoch; Nithsdale; Kintyre; Borders; *Newton Stewart*; Lockerbie
Cluster 9 comprises forest districts with extensive areas of young conifer species particularly spruce. Windthrow hazard class is high with large areas in hazard classes 5 and 6. Because of this many areas will be poorly roaded and non-thin will be common.

Cluster 10: Wester Ross; Strontian; Fort Augustus; *Lorne*; Lochaber
Cluster 10 covers a number of forest districts also with large areas of young conifers but significant amounts of older conifers (planted 1921–40) are also present. Windthrow hazard classes tend not to be as high as in cluster 9.

Cluster 11: Kielder; Mull; Afan; *Castle Douglas*
These forest districts also have a high proportion of spruce but there is a greater range of age classes than in cluster 9. Their most characteristic feature is that Forestry Commission land comprises a large proportion of all land within the forest district boundary.

Cluster 12: Aberystwyth; Newtown; Dolgellau; Llandrindod; Corris; *Ruthin*; Brechfa
The forest districts in this cluster are all in Wales and have an above average proportion of crops in the 1921–40 and 1941–65 age classes.

Cluster 13: York; Weald; Northants; Chilterns; West Downs; *Dean*; South Downs; Wiltshire
Cluster 13 comprises forest districts in lowland England with an above average proportion of broadleaves.

Cluster 14: North Lincs; Suffolk; Sherwood; Midlands; *Thetford*; Moray; Dorset
The forest districts in cluster 14 are also to be found in lowland areas but with a higher proportion of pines. With the exception of Suffolk Forest District which lost many of its older crops in the storm of October 1987, stands of over 50 years of age are common.

fers from, and is in many respects superior to, the previous hierarchical techniques in that it admits relocation of Forest Districts, thus allowing poor initial partitions to be corrected at some later stage in the analysis; it also identifies the variables which most characterise the Forest Districts within the cluster, thus permitting interpretation of the clusters.

The final classification chosen generated 14 clusters of which four were single Forest Districts. The clusters are listed in Table 5.3 and shown in Figure 5.1. Table 5.3 also provides a written description of the main characteristics of each cluster. Note, however, that every Forest District in a cluster does not necessarily show exactly the same distinguishing characteristics. Discussions with Forestry Commission staff confirmed the logic and interpretation of this pattern, which was used to select the Forest Districts for sampling in the project.

Chapter 6
Visitor Surveys

The survey strategy and programme

Six Forest Districts were surveyed in 1987, of which two (Durham and North York Moors) occur in the same cluster; the reason for duplication was that the 1987 survey also investigated additional questions particularly concerning wildlife conservation values. Aberfoyle (cluster 7) was the subject of an independent study in 1987 (Hanley, 1989) and these data were available for re-analysis as part of the present study. Surveys in the eight remaining clusters were therefore made in 1988. The sample Forest Districts surveyed are shown in Table 6.1.

For each cluster, the survey Forest Districts and sites within Forest Districts were selected in consultation with the Forestry Commission's Development Division and with advice from the Forestry Commission's recreation and conservation specialists. The Forest District Manager in each Forest District provided general guidance and data on visitor numbers and patterns of use and recreational provision at each site. Site guides, trail leaflets and other literature were collected, and unpublished data on visitor numbers obtained locally or from the Forestry Commission's Recreation Branch.

The main objective of the visitor surveys was to obtain data on visitor numbers, characteristics and origins in order to provide the variables necessary to perform a travel cost calculation (see Chapters 4 and 7) and so estimate the overall use-benefits at each site. The questionnaire was intentionally kept short and compact in order to minimise boredom or inconvenience for respondents and to simplify handling and management by the interviewers. In general the interviewers found no difficulties overall or with individual questions; only the question on income was resisted to a significant extent, in which case income was estimated from the response to an employment question. The overall refusal rate was very low (2–3%).

All rural recreation sites pose difficulties for visitor counts and surveys because entry charges are rare and in any case would be difficult to manage because access is often at multiple points or along unenclosed boundaries. Visitor intensity per unit area is also relatively low. The intensity of sampling must therefore be matched to the resources available and a judgement made as to what is feasible and practical, bearing in mind the search for statistical significance in any results obtained and the influence of diurnal and seasonal factors on visitor behaviour (Collings and Grayson, 1977). The present project was designed to rely on existing Forestry Commission data for total annual visitor numbers, and one factor in site selection was the availability of at least some such data (see Chapter 8).

Guidelines (Tourism and Recreation Research Unit, 1983) were used to devise a survey strategy at each site comprising work on at least 10 days during July–September, divided to include both weekdays and weekend days, both inside and outside the main school holiday period.

The survey period was 11.00–18.00 approximately each day. The dates varied between sites due to weather and organisational factors but in general resulted in a good and comparable balance between sites, except at Loch Awe and Castle Douglas (Clatteringshaws). At Loch Awe the visit rate was so low that it was decided that

Plate 1. *Access by car to Dalby Forest, North Yorkshire.*

Plate 2. *Tranquility at the water's edge; Bolderwood, New Forest, Hampshire.*

Plate 3. *Picnic in Achray Forest, Queen Elizabeth Forest Park, Central Region.*

Plate 4. *Enjoying the attractive Chiltern beechwoods in late spring.*

Plate 5. *An autumn stroll in Achray Forest.*

it was not cost-effective to continue until the target was reached. Loch Awe forms a singleton cluster and this does not therefore have a major impact on the overall strategy for the project. At Clatteringshaws, on-site interviewing was limited, but is supplemented by detailed data from visitor books at the Deer Museum. Table 6.1 shows the numbers of interviews completed at each site.

Because the survey was concentrated in the summer months, there is a possibility that seasonal variation in the origin or characteristics of visitors may be biasing the results. It is probable, for example, that winter visitors travel shorter distances and stay for shorter periods than summer visitors. This must be borne in mind when interpreting the results presented in later sections.

Table 6.1 Survey districts, survey sites and sample sizes.

Cluster district	*Survey sites*	*Questionnaires*
1 New	Rhinefield	316
	Bolderwood	
2 Cheshire	Delamere	320
3 Loch Awe	Arinechan	
	Kilmaha	
	Timberwalk	56
	Inverinan	
	Barnaline	
	Avich Falls	
4 Brecon	Garwnant	236
	Taf Fechan	
5 Buchan	Back O'Bennachie	
	Rowan Tree	195
	Essons	
	Donside	
6 Durham	Hamsterley	483
North York Moors	Dalby	387
7 Aberfoyle	Queen Elizabeth (visitor centre/drive)	*
8 South Lakes	Grizedale (visitor centre car parks)	322
9 Newton Stewart	Stroan Bridge	213
	Bruce's Stone	
10 Lorne	Ben Lora	
	Catnish	
	St Colomba's Bay	202
	Sutherlands Grove	
	Glen Creren	
11 Castle Douglas	Clatteringshaws (deer museum and deer range)	66+
12 Ruthin	Moel Fammau	305
13 Dean	Symonds Yat	267
14 Thetford	Thetford (Lynford Stag/St Helens)	255

* Hanley, 1989.

Survey sites

The following paragraphs briefly describe each Forest District selected for detailed study, and the specific forests and visitor sites at which surveys took place (Table 6.1).

Castle Douglas (Clatteringshaws)

This Forest District is in the highlands of southwest Scotland where the Forestry Commission began tree planting in 1922. The area forms part of the Galloway Forest Park designated in 1943. A particular focus for visitors is red deer, at the Clatteringshaws Deer Museum and the red deer range nearby (a wild goat park adjoins the range).

South Lakes (Grizedale Forest)

Grizedale Forest lies between Lake Windermere and Coniston Water, 2 miles south of Hawkshead, in the Lake District National Park. The Forestry Commission purchased the estate in 1937, but further purchases and leases increased the area to a present total of 3500 ha. The area was designated a Forest Park in 1987. Provision for recreation and wildlife conservation is substantial (Chard, 1972). Attractions for visitors include a new visitor centre opened in 1987 as well as car parking and picnic facilities, forest trails and walks, a conservation nursery with young trees on sale, and play facilities for children.

The complex in the centre of the forest also includes the Theatre in the Forest, a camp site (Camping Club of Great Britain), self-catering cottage and hostel accommodation, and a forest lodge hotel and restaurant. A unique feature of the forest is the forest sculpture project, which began in 1977 with sponsorship by Northern Arts, in which the works of many sculptors are sited close to the Silurian Way.

North York Moors (Dalby Forest)

Dalby Forest is part of the Forestry Com-

mission's estate of more than 10 000 ha lying in the southern part of the North York Moors. The recreational facilities based on a forest drive (giving access to two nature reserves), footpaths, open spaces with picnic facilities, and a visitor centre and natural history museum are all contained within an area of 4500 ha, three-quarters of which is afforested with a predominance of pines.

The Dalby Forest Drive is 14 km long linking public roads between Thornton Dale and Hackness. The information centre at Low Dalby village includes an exhibition of the forest and its wildlife. Features along the drive include many short and long walks and way-marked trails, Staindale Lake, a scenic viewpoint and a forest garden. Access is possible to Bridestones Moor Nature Reserve (National Trust and Yorkshire Wildlife Trust) and Ellerburn Bank Nature Reserve (Yorkshire Wildlife Trust).

Durham (Hamsterley Forest)

The Forestry Commission purchased the Hamsterley Estate (2086 ha) in 1927 when the agricultural and sporting land included mainly heather moorland (67%) and upland pasture (18%). Planting took place mainly between 1927 and 1951, so that the present distribution of land-use comprises coniferous plantation (86%), and smaller proportions of broadleaved woodland (4%), pastures and meadows (5%), forest rides, roads and recreational land (5%).

Recreational use of the forest is encouraged through the provision of parking and picnic facilities, a visitor centre and residential field centre, a 7 km forest drive, a wayfaring course and several way-marked circular walks. There is Forestry Commission and voluntary investment in wildlife management, bird and bat boxes, pond creation and species recording.

Thetford (Thetford Forest)

The Forestry Commission acquired Thetford Forest in the 1920s and 1930s; planting began in 1922 and most of the area was afforested by 1937. The forest covers an area of over 20 000 ha and is dominated by Scots pine, although this is being replaced by Corsican pine as felling and restocking takes place.

Recreation facilities in the forest include horse riding trails and bridleways, way-marked forest walks, a camping and caravan site (Thorpe Woodlands), and parking and picnic places. The forest is used, like many others, for specific events such as orienteering, shooting and car rallies. A large area is set aside as a Ministry of Defence training area. Although information services and guided walks are provided from the Forestry Commission offices in Santon Downham, there is no major interpretive or visitor centre.

Wildlife interest in the forest is significant and this is being promoted through the launch in 1987 of a bird trail (Forestry Commission, 1987a). The nesting of red-backed shrikes is a particular attraction.

The forest has been used for a special case study of the opportunities and costs of modifying forest management in the interests of wildlife diversification and conservation (Simpson and Henderson-Howat, 1985).

Dean (Symonds Yat)

The Forest of Dean is a National Forest Park (1938) bordering an Area of Outstanding Natural Beauty. As an ancient Royal hunting forest, with a variety of ancient rights and a long history of woodland management, mining and other human activity, the attractions and use of the area for tourism, holidaymaking and day visits is substantial (Colenutt and Sidaway, 1973).

Symonds Yat, on the western edge of the Forest Park, is a well-known beauty spot with a viewpoint overlooking the Wye Valley. It is a major concentration point in the forest, for example attracting 30% of existing day use in 1968, and is severely congested at peak weekends. A 6 km forest walk starts at the car park and passes through the Highmeadow area of mixed woodland.

A particular attraction for the public is the peregrine falcons which nest on Symonds Yat rock (RSPB, no date). Birds bred here until the early 1950s, but pesticides drastically reduced the national population. Re-occupation of the site started in 1982, and in 1984 the Forestry

Commission and the Royal Society for the Protection of Birds set up a protection scheme which has involved wardening and interpretation for visitors.

Brecon (Garwnant and Taf Fechan)

The Brecon Forest District comprises the former forests of Brycheiniog, Coed Taf, Glasfynydd, Mynydd Du and Talybont, and coincides approximately with the Brecon Beacons National Park. The park obviously attracts a large number of tourists and visitors, and a number of car parks, picnic places and trails are provided by the Forestry Commission. Surveying took place at the Garwnant Visitor Centre and at Taf Fechan.

Buchan (Bennachie)

Buchan Forest District in north-east Scotland contains one major forest area subject to relatively heavy recreational use, at Bennachie, and all survey work was concentrated here. The Forestry Commission acquired the land after the Second World War and planted mainly Scots pine, larch and spruce, leaving the high tops of the mountain range unplanted. Car parks giving access to trails and the mountain slopes encircle the range, and survey work involved regular visits to each, at Esson's, Back o' Bennachie, Rowan Tree and at the Donview Centre which includes a visitor centre, exhibition and toilets. Three of the car parking areas have picnic sites.

Cheshire (Delamere Forest)

The Cheshire Forest District contains a small amount of Forestry Commission land comprising the Delamere Forest, and all survey work took place here. The forest is relatively small and isolated, and surveyors moved around the forest to carry out interviews, but excluded car parks in and around Hatchmere Village.

Loch Awe (Inverliever Forest)

This Forest District is relatively small in size but with a high proportion of Forestry Commission land, and forms a singleton cluster because of this and because of the very heavy commercial recreational use of the Forestry Commission's forest cabins and cottages on Lochaweside. Informal recreational provision is on the north-western side of the loch, in Inverliever Forest; facilities include waymarked walks, viewpoints adjacent the public road, and picnic places. Of note is the Dalavich Oakwood Trail in a semi-natural broadleaved wood which includes a Site of Special Scientific Interest.

Surveys were carried out on 10 days but only 56 questionnaires were completed. Showers and heavy rain on some days had an effect, as at other Forest Districts, but the surveyors discovered that the number of cars was relatively small. Holidaymakers in the cabins were not interviewed unless they were encountered in the forest. Because of the very low success rate in the area, the number of survey days was not extended and the results obtained for the Forest District must therefore be treated with some caution.

Lorne (Barcaldine)

Lorne Forest District includes the former forests of Barcaldine, Glenorchy and Fearnoch. Visitor surveys at Catnish (Glenorchy) were unproductive and effort was concentrated at Barcaldine, in a number of places where car parks and picnic places give access to a variety of short and long forest walks, some leading to adjacent summits.

New (Bolderwood and Rhinefield)

The New Forest is a unique area of major national significance (Tubbs, 1986; Forestry Commission, 1987b). That part of the New Forest in public ownership, commonly known as the Crown Land, covers an area of some 26 929 ha, and is administered by the Forestry Commission. A further area is in private ownership, and is essentially 'forest' in character, scarcely distinguishable from the Crown Lands. The New Forest District Council has defined a New Forest Heritage Area which is approximately twice the size of the Crown Land area. The use of the area for leisure and recreation is substantial; in 1969 the area received an estimated 3.5 million day visitors but this had increased to an estimated 8 million in 1987. In 1987 there were 143 day visitor car parks on

Forestry Commission land with a total capacity of 5263 spaces.

The selection of sites for the survey was clearly difficult given 143 car parks and millions of visitors. After discussions with Forestry Commission staff and a reconnaissance visit, it was decided to concentrate the survey at Bolderwood (which had been subject to traffic monitoring between 1972 and 1986) and the nearby area of Rhinefield. These areas lie in the heart of the forest, include forest walks and picnic places, and the monitored use of Bolderwood suggests that it is reasonably representative of intensively used informal recreation areas in the forest.

Newton Stewart (Glen Trool)

This Forest District, in south-west Scotland, includes part of the Galloway Forest Park designated in 1943. Planting in the area began in 1922, mainly of spruces, pines and larches. There are now a variety of forest walks, caravan and camp sites, picnic and parking places. Promotion of recreational use of the forest park also involves the adjacent Forest Districts of Castle Douglas, Dumfries, and Ayrshire and Arran. There are two main focal points for visitors, at the Kirroughtree Visitor Centre and Glen Trool; all interviews were carrried out in Glen Trool, in the areas of Stroan Bridge and Bruce's Stone. At each a variety of waymarked trails radiate from car parks with picnic places.

Ruthin (Moel Fammau)

Ruthin Forest District lies in North Wales and comprises the former forests of Clocaenog, Clwyd and Ceiriog. Surveys were concentrated at Moel Fammau, a car park and picnic area with adjacent walks and trails in Clwyd Forest.

The total survey in 1987 and 1988 (excluding Aberfoyle) comprised 3623 questionnaires, representing more than 11 000 visitors, distributed as shown in Table 6.1. The selection of survey Forest Districts was based on a cluster analysis of the whole estate, using a large database, and is therefore representative of the diversity within the estate, from remote and relatively young coniferous plantations in Scotland, to areas in lowland England with a greater proportion of broadleaved trees and subject to intense visitor use (Chapter 5). Within each Forest District, the visitors at each site represented a broad cross-section of the public, and an analysis of their characteristics and their countryside trip (Willis, Benson and Whitby, 1988; Willis and Benson, 1989a) shows both to be very similar in most respects to other countryside visitors and trips (Countryside Commission, 1985; Central Statistical Office, 1990).

Chapter 7

Consumer Surplus

Calculating demand and consumer surplus

The basic model is:

$$V_{ij}/N_i = f(TC_{ij}, T_{ij}, S_{ij}, A_{jk})$$

where

- V_{ij} = number of visitors in sample from area i to forest j
- N_i = population of area i
- TC_{ij} = travel costs from area i to forest j
- T_{ij} = time costs from area i to forest j
- S_{ij} = socioeconomic characteristics of residents at area i who visit forest j
- A_{jk} = attributes of forest j in relation to other substitute recreation sites (k).

The reason for concentrating on travel costs is that these provide the only source of variation in supply price in a cross-sectional study. The cost of the resource is constant but that of the whole experience is uniquely determined for each individual by their location relative to the site. Hence an initial demand curve can be derived by aggregating individual visits according to distance from the site and estimating a distance decay function relating the numbers of visits to distance from the site. Translating distance into monetary terms, by standard vehicle operating cost data or fares, and standard values of time, provides the normal price–quantity relationship.

Individual visitors are aggregated by distance zones. Here 20 zones of 5 mile intervals concentric to the site, plus the remaining area >100 miles, were adopted. Old local authority areas have been employed (Lewis and Whitby, 1972), but existing local authority areas are often too broad in scale in relation to a local recreation site. The number of zones must be small enough in relation to sample size to produce statistically significant visit rates between areas (to avoid variations in the dependent variable being purely stochastic due to small numbers of observations) but the number of zones must be large enough to undertake a regression analysis, since the visit rate per zone forms the dependent variable. The important characteristic of zones is that travel costs from all points within a zone are sufficiently close in magnitude to justify neglecting the difference. TC_{ij} is thus the (average across each zone) marginal cost of visiting a forest.

Visit rates per capita (V_{ij}/N_i) per sample for each zone were determined by dividing the number of visitors in the sample from each zone to a particular forest by the zone's population. The variables can be derived either from the surveys or from the Census of Population for each zone. Transport costs for private cars were derived from the Royal Automobile Club and based on the full cost of car ownership (petrol, maintenance, depreciation, insurance and taxes) rather than just petrol cost alone. Varying parameters have been chosen to value non-working time (Seller, Stoll and Chavas, 1985), but since the Department of Transport (1987) recently re-evaluated non-working time in Britain for transport appraisal purposes at 43% of earnings, with lower rates for children and non-wage earners, these official values were adopted. These willingness-to-pay values were adjusted by responses to a contingent valuation question on the enjoyment from the visit to the site as a proportion of the enjoyment derived from the total trip, to overcome the multiple trip problem. Socioeconomic data from the

Census comprised numbers and percentages of persons in households with the head in socioeconomic groups 1 to 4 plus 8 and 9; social classes 1 and 2; economically active in social classes 1 and 2; and households with 1 or more cars. The socioeconomic group and social class variables were intended as a proxy for income, while it is reasonable to suppose that any variations in car ownership would influence visit rates to the sites since most forest sites are relatively inaccessible by public transport. The two social class variables were highly correlated, so the percentage economically active social class variable was excluded. The correlation coefficient between all other independent variables was less than 0.6.

Having specified the variables to be included, the functional form of the model needs to be determined. Theory does not suggest a particular functional form, so various models were tested against the data:

Model	Linear transformation
$V_{ij}/N_i = a_0 + a_1P + a_2Y \ldots$	
$V_{ij}/N_i = bP^{b1} \cdot Y^{b2} \ldots$	$\log(V_{ij}/N_i) = b_0 + b_1 \log P + b_2 \log Y \ldots$
$V_{ij}/N_i = e^{c + c1P + c^{2Y}} \ldots$	$\log(V_{ij}/N_i) = c_0 + c_1P + c_2Y \ldots$
$V_{ij}/N_i = 1/(d_0 + d_1P + d_2Y \ldots) \ldots$	$1/(V_{ij}/N_i) = d_0 + d_1P + d_2Y \ldots$
$V_{ij}/N_i = g_0 + g_1(1/P) + g_2(1/Y) \ldots$	$V_{ij}/N_i = g_0 + g_1(1/P) \ldots$

Table 7.1 Trip generation and demand function regression results.

Forest	*Constant*	*Full distance cost*	*Cars*	*Social class (1+2) zone*	R^2 *(%)*
New Forest	−6.9496	−0.7021		11.5027	0.9657
	(1.1438)	(0.0408)		(3.9138)	
Cheshire	−9.8929	−0.5252	4.4685		0.9908
	(1.0529)	(0.0189)	(1.4985)		
Loch Awe	−11.8110	−0.3021	9.2899		0.8241
	(2.1167)	(0.0598)	(2.8914)		
Brecon	−9.9515	−0.3837	4.5087		0.8518
	(1.6266)	(0.0392)	(2.4549)		
Buchan	−4.2843	−0.4442			0.8033
	(0.6820)	(0.0634)			
Durham	−11.6374	−0.5911	13.6293		0.9119
	(2.2537)	(0.0515)	(3.5309)		
N. York Moors	−6.7342	−0.5491	5.0872		0.9107
	(2.5352)	(0.0543)	(3.3426)		
Aberfoyle	−9.1030	−0.3901	8.1693		0.7513
	(1.6896)	(0.0566)	(2.7381)		
S. Lakes	−12.3680	−0.7969		20.6201	0.9498
	(3.1062)	(0.0489)		(6.4390)	
Newton Stewart	−2.2715	−0.6221			0.8531
	(0.7573)	(0.0666)			
Lorne	−4.9182	−0.6937	6.0074		0.9505
	(2.0781)	(0.0517)	(2.8288)		
Castle Douglas	−7.4233	−0.4415	5.0778		0.8505
	(1.8953)	(0.0512)	(2.5171)		
Ruthin	−6.5265	−0.3963			0.9040
	(0.3363)	(0.0333)			
Forest of Dean	−12.3965	−0.4732	9.3891		0.9110
	(2.8328)	(0.0445)	(3.5707)		
Thetford	−10.4823	−0.3989	6.2448		0.9417
	(2.4350)	(0.0390)	(2.8788)		

Only results significant at 15% level included.
$n = 21$ in all cases. Standard deviation in brackets.

Model specification was determined in terms of R^2, and also the predictive ability of the model in estimating visitor numbers. The predicted numbers of visitors by the semi-log models were within +4.4% of actual visitor numbers on average over all forests, varying from +35.3% in Lorne to +0.2% at Thetford, and –5.8% at Brecon. The semi-log model also had higher R^2 values; higher correlation coefficients between predicted visitor numbers and actual visitor numbers over distance zones; and did not predict, unlike the linear model, negative visit numbers for some zones.

Table 7.1 presents the final semi-log model results for each forest including only those explanatory variables which were statistically significant in explaining visit rates. The power of the gravity effect (travel cost plus time) tends to dominate. It may be surprising at first sight that income (or social class or socioeconomic group as a proxy for income) does not appear as a consistent estimator. However, this is similar to other Clawson–Knetsch studies which have also estimated a weak (Lewis and Whitby, 1972) or zero (Everett, 1979) explanatory effect between income and visit rates. This may not be so surprising given the very high proportion of visitors arriving by car at the sites; the importance of access to a car as a means of reaching these forests, mainly unserved by public transport; the fact that travel cost is a small proportion of income; and some correlation between car ownership and income.

Consumer surplus results

Consumer surplus or net benefit for each individual is the area under the demand curve minus the price or cost of the trip (Figure 2.1). Integrating over the function produces the relevant consumer surplus estimate for the sample, which needs to be divided by the total visitor numbers in the sample to give the consumer surplus value for each visitor to each forest within its representative cluster (Table 7.2).

Consumer surplus per visitor varies from £1.34 in the South Lakes (cluster 8) to £3.31 at Loch Awe (cluster 3). The only cluster (6) in which two different Forest Districts were sampled produced estimates only 29 pence apart, of £1.64 for Durham and £1.93 for North York Moors. These values are also contiguous in ranking in terms of consumer surplus per visitor, except for the singleton Cheshire Forest District which intervenes. This provides some confidence that the results are robust and reasonable.

The Loch Awe demand curve was based on very few observations (56 completed questionnaires covering 145 people) so the consumer surplus per visitor may be suspect. Apart from Loch Awe, the highest consumer surplus per visitor is around £2.60 (Aberfoyle £2.72; Thetford £2.66; Brecon £2.60; Ruthin £2.52 and Castle Douglas £2.41), with an average (visitor weighted) consumer surplus for all forests of £2.00.

The robustness of these results could be challenged on a number of grounds. First, it could be argued that car ownership is not a truly independent variable, i.e. independent of other explanatory variables, and since car ownership itself is normally explained in terms of these same independent variables, this may lead to biased estimates of coefficients (Vickerman, 1975). Table 7.2 (column 2) shows the consumer surplus estimates if cars are removed as a variable. In the case of Cheshire, North York Moors, South Lakes and Lorne the inclusion or exclusion of cars makes little difference. In the case of the other forests, the change is more noticeable. For Loch Awe, North York Moors, Dean and Thetford, the exclusion of cars decreases consumer surplus. For Brecon, Durham and Aberfoyle, the exclusion of cars would increase consumer surplus. These results are ambiguous or not consistent in their direction. However, since the percentage of households with one or more cars was included as a proxy for socioeconomic variables, and no other socioeconomic variables were included with cars in any equation (because they failed to meet the (rather low: 15%) significance test), it does seem justifiable to accept the inclusion of cars as a variable in the equations.

Second, it might be expected that the exclusion of substitute sites and places to visit in the demand equations (Table 7.1) would bias the co-

Table 7.2 Clawson-Knetsch travel cost consumer surplus estimates (£ at 1988 prices).

Cluster	*District*	*Consumer surplus per recreational visitor*	*Consumer surplus per recreational visitor (travel cost only)*
1	New	1.43	–
2	Cheshire	1.91	1.87
3	Loch Awe	3.31	2.67
4	Brecon	2.60	2.84
5	Buchan	2.26	–
6	Durham	1.64	1.91
6	North York Moors	1.93	1.90
7	Aberfoyle	2.72	3.15
8	South Lakes	1.34	1.38
9	Newton Stewart	1.61	–
10	Lorne	1.44	1.37
11	Castle Douglas	2.41	2.25
12	Ruthin	2.52	–
13	Dean	2.24	2.07
14	Thetford	2.66	2.31

efficients and the results. Since the substitute site/place variable did not prove instrumental in determining the model, the issue was further explored with a regression using observations based on individual visitors. To maximise the number of observations, the analysis was performed across all sites. In the surveys, respondents were asked contingent valuation questions: 'Suppose that this (forest) site was not available for visits. Where might you go instead for the same enjoyment and the same or even a different interest? . . . forest, . . . other place.' Responses were used to construct dummy variables: e.g. whether the respondent thought a substitute forest (place) existed or not. Table 7.3 presents the results for these two coefficients. The presence of a substitute forest reduced willingness-to-pay (and appeared statistically significant) as would be expected. However, the coefficient for the substitute place variable had the wrong sign and was not statistically significant. This least squares regression result can be validated by a jack-knife regression in which each observation is compared with the equation generated when that observation is left out. In such a jack-knife regression the presence of a substitute forest no longer proved a statistically significant variable determining willingness-to-pay. Consequently, it was concluded that any effect of substitute sites was not biasing the results in a significant way.

Table 7.3 Regression results of willingness-to-pay and substitute sites.

Variable	*Estimate*	*STD error*	*T ratio*	*Prob>|T|*
Ordinary least squares regression $R^2 = 0.0880$				
site visit length	0.05556	0.01864	2.9802	0.0032
sub forest	–0.17612	0.08367	–2.1050	0.0365
sub place	0.19122	0.11820	1.6177	0.1072
Jack-knife regression $R^2 = 0.0875$				
site visit length	0.05861	0.06179	0.9485	0.3440
sub forest	–0.18476	0.17853	–1.0348	0.3019
sub place	0.20000	0.14367	1.3924	0.1653

Dependent variable: willingness-to-pay per capita as an entrance charge.

Sensitivity analysis

The sensitivity of the foregoing results to the assumptions used in the travel cost method model can be assessed by varying some of the variable parameters.

The five alternative models evaluated were:

1. the value of leisure time equal to 25% of wage rate,
2. the value of leisure time equal to zero,
3. travel cost as perceived by visitors to each forest,
4. petrol cost only of travel, and
5. petrol cost only plus time at the standard rate of 43% of earnings.

Alternative Model (1): Time could be valued at the rate applied by the Department of Transport before its 1987 review. This value of non-working time was taken to be 25% of the wage rate. In this model the value of other variables remains as reported in the previous section.

Alternative Model (2): Many travel cost method studies do not incorporate time as a specific cost element. Hence, it might be assumed, probably somewhat unrealistically, that leisure time has no value or opportunity cost to individuals. This assumption implies that an individual would receive no leisure benefit from not visiting the forest and undertaking some alternative activity instead. Other elements remain the same as in the standard model.

Alternative Models (3), (4) and (5): The three other models concern the cost of travel or transport to each site. There may be some doubt or uncertainty in people's minds as to the exact cost of travel to the sites, or they may simply misjudge the true cost. To explore people's perceived transport costs, the questionnaire included a further contingent valuation question: 'about how much do you think it costs to run your car . . . in pence per mile?'

The average costs of running a car, as perceived by respondents, were substituted into the travel cost model (Model (3)). These (average) costs ranged from 17.7p per mile at Loch Awe to 27.1p per mile at Lorne. Clearly perceived costs are reasonably close to the average full travel cost per mile of 33p which was used in the standard travel cost method reported earlier. However, the variance among respondents was considerable, and varied from 0p per mile to 99p per mile, presumably reflecting the range from company vehicles complete with free fuel to infrequently used vehicles incurring high depreciation costs. In this model, time is valued at the same rate as in the standard model.

It could be argued that vehicles are pur-

Table 7.4 Consumer surplus estimates per capita by forest under varying assumptions (£ per visit, 1988 prices).

	'Standard model'	*Time = 25% of wage rate*	*Time = 0% of wage rate*	*Estimated travel cost*	*Petrol only*	*Petrol + time = 43% of wage rate*
New Forest	1.43	1.40	1.36	0.93	0.33	0.40
Cheshire	1.91	1.87	1.81	1.25	0.44	0.54
Loch Awe	3.31	3.21	3.05	1.92	0.73	1.00
Brecon	2.60	2.56	2.50	1.70	0.61	0.71
Buchan	2.26	2.22	2.16	1.67	0.52	0.63
Durham	1.64	1.77	1.73		0.54	
North York Moors	1.93	1.87	1.84		0.59	
Aberfoyle	2.72	2.59	2.37		0.61	0.95
South Lakes	1.34	1.30	1.27		0.41	
Newton Stewart	1.61	1.57	1.53	1.24	0.36	0.45
Lorne	1.44	1.40	1.35	1.10	0.33	0.42
Castle Douglas	2.41	2.36	2.54		0.72	
Ruthin	2.52	2.47	2.40	1.72	0.58	0.70
Forest of Dean	2.34	2.19	2.13		0.69	
Thetford	2.66	2.62	2.55		0.76	

chased on the basis of other work and leisure pursuits and not just because of the occasional visit to a forest, in which case car ownership could be viewed as a sunk cost, and that visiting a forest occasionally incurs only a marginal cost in terms of petrol and servicing. Thus an alternative assumption is to base costs on marginal costs only, which would reduce travel costs to about a quarter of those assumed in the standard model (i.e. approximately 8p per mile), with time values at 0 (Model (4)) or at 43% of earnings (Model (5)).

The consumer surplus estimates per capita under these varying assumptions are shown in Table 7.4. Contrary to expectations, varying the value of time actually had little effect (this may partly be a function of the way in which time was treated in the model, i.e. adding it to travel cost to avoid multicollinearity in the estimating econometric equation. A priori time may be expected to have a much more significant effect).

Varying travel costs did produce significantly different results. If the cost of access really did amount to only the cost of petrol (with time cost equal to zero), then the consumer surplus per capita is reduced dramatically. Even with leisure time included at the Department of Transport's (1987) recommended rate of 43% of earnings, consumer surplus per capita is still quite low. This is consistent with the results of a travel cost method study of visitors to Sites of Special Scientific Interest on agricultural land (Willis and Benson, 1988).

Finally, it is of interest to compare the estimates of consumer surplus with the limited number of other studies of forest recreation (Table 7.5).

Consumer surplus obviously varies between forests on a per visitor or on a per hectare basis. The average times estimated to be spent by visitors at Forestry Commission sites in 1971 (Grayson *et al.*, 1975) and in the present study are significantly different (1.5 and 2.97 h), which may partly account for the apparent growth in consumer surplus per visitor. Also, the Grayson method of extrapolation to all forests (£32.33 ha^{-1}) was different from the method we use to estimate £33.69 ha^{-1} (for the 1987 study sites) and £47.00 ha^{-1} for the 1987 and 1988 sites aggregated over the whole UK. Applying Grayson's calculation to our estimate of consumer surplus per visitor gives an estimate of £106.54 ha^{-1}. We think this is too high.

Table 7.5 Consumer surplus estimates from various forest recreation studies (all figures in £ at 1988 prices).

Study (year/author)	*Consumer surplus for all recreation*	
	Per visitor	*Per hectare*
1969–71 All Forestry Commission forests aged 25+ years		
Grayson *et al.* (1975)	0.35	32.33*
1975–76 Dalby		
Everett (1979)	1.93	68.48†
1981 Gwydyr		
Christensen (1983)	0.56	–
1987 Queen Elizabeth Forest Park		
Hanley (1989)	1.70¶	–
1987 Six sites		
Present study		
(a) Six sites	2.01	33.69‡
(b) Six sites	2.01	106.54§
(c) Dalby only	1.93	55.58†
1987 + 1988 sites	2.00	47.00

* calculation from consumer surplus per visitor is: consumer surplus per visitor × all forest visitors divided by total area of Forestry Commission land aged 25+ years (Grayson *et al.*, 1975).

† different estimates of annual visitor numbers produce different estimates of consumer surplus per hectare.

‡ calculation from consumer surplus per visitor is: 2.01 × total visitors to six sites divided by total area of six sites.

§ calculation from consumer surplus per visitor is: 2.01 × all UK forest visitors divided by total area of Forestry Commission land aged 27+ years (i.e. same as/similar to *).

¶ 1987 prices; range 32p – £15.13 for different model functional forms.

The estimate for Gwydyr Forest (Christensen, 1983) is closer to the Grayson estimate than to our estimate, but was produced as part of a methodological study using a small sample (the models developed for Gwydyr were diverse and complex, and the estimate quoted is the most cautious of several calculated). For Aberfoyle (Hanley, 1989), the estimate of £1.70 is based on travel costs of 22p per mile and no time costs. For the only forest common to two studies – Dalby – the estimates of consumer surplus per visitor are identical when indexed to 1988 prices.

One possible explanation for some of the differences between studies is the treatment of travel costs. Results are sensitive to this factor but there is an argument for the use of a full cost approach to travel. However, the consumer surplus per visitor in the present study using a marginal cost approach – mean (weighted) £0.63 – is very similar to the indexed estimates of Grayson and Christensen. Unfortunately neither author is at all explicit as to how travel costs were calculated, nor does Everett make his approach clear. Given that entry fees at many National Trust, English Heritage and similar properties (which include gardens, parks, woodlands and forests) are closer to our higher estimate (£2.00), this figure seems realistic and plausible for car-borne forest visits of the kind studied in this project.

Chapter 8

Recreation on the Forestry Commission Estate

Introduction

In this chapter we first review and summarise the results from surveys of visitors to the Forestry Commission's estate carried out in 1968 and 1977. Secondly we review other data on trends in countryside recreation before describing the results obtained for recreation on the estate in 1987/88 from a survey of Forest District Managers. Finally we review national data from the Countryside Commission and other organisations to provide a comparison with the overall totals obtained from the survey of Forest District Managers. The objective is to obtain estimates of visitor numbers by Forest District and by cluster for use in aggregating the individual estimates of consumer surplus.

Forestry Commission visitor surveys 1968 and 1977

The Forestry Commission (Grayson, Sidaway and Thompson, 1975) undertook a sample survey in 1968. The ranges estimated are large; the annual summer seasonal total of 10.2 to 22.2 million implies an overall annual total in the range of 15-32 million (middle of range 24 million).

A survey in 1977 (Collings, 1977) produced an overall estimate of 15 million for the summer season (May-September) and 24 million for the whole year (Great Britain).

It is difficult to assess the change (if any) in use of the Forestry Commission's estate between 1968 and 1977 because of the wide ranging estimates obtained in 1968. In 1977 a Countryside Commission survey estimated a total of some 550 million countryside trips (England and Wales); the estimate by the Forestry Commission for 1977 represents 3.3% of this total. The Countryside Commission survey showed that the main stop on about 3% of countryside visits was to 'woodland'; but this is not a consistent comparison given that the Forestry Commission estate is only about half of all woods and forests in the country and the Forestry Commission survey was concerned with all visits, not just main stops.

National trends in countryside recreation

A characteristic of the last half of this century has been the rapid increase in the use of the countryside for recreation. In parallel with increasing urbanisation, the decreasing length of the average working week and the increases in the average span of life with a fixed retirement age, there has been increasing affluence, better transportation and communication facilities and broadened education. It is believed that an increasing proportion of the population visit the countryside every year for recreational purposes.

During the period 1968–78 (Countryside Commission, 1980), there was a consistent pattern of rapid growth in tourism and recreation demand up to 1973, a marked decline in 1974 (incoming tourism excepted) following the 'energy crisis', with recovery of growth in most sectors up to 1978. In the late 1970s recreation forecasting was extremely difficult due to the general lack of trend data and poor recording of recreation behaviour. The general prospect after

1980 was seen to be continuing growth but at a lower rate than in the previous decade.

The potential effects of changes in petrol prices and car ownership during the 1970s are complex, but Bovaird, Tricker and Stoakes (1984) conclude that these factors do not alone provide a convincing explanation for the downward trend in trips, although large increases in petrol prices do appear to have had short-term effects. An examination of other economic indicators, such as GDP, consumer expenditure and unemployment levels, also shows a complex relationship between these factors and leisure trips.

Visits to Forestry Commission land 1987/88

Despite the absence of a recent co-ordinated national site survey, some local monitoring is carried out especially at visitor centres and major car parks. Also, individual Forest District Managers, Rangers and other staff have a qualitative and sometimes quantitative knowledge of the intensity of recreational use of car parks and other facilities; in some cases a local authority or other agency has carried out visitor counts on Forestry Commission land.

Each Forest District Manager was asked to estimate the overall use in 1987/88. The estimates are aggregated and summarised by Conservancy (1977 boundaries) in Table 8.1, while further details can be found in Benson and Willis (1990).

The data obtained in this way are clearly very variable. Except in the case of specific monitored sites it is impossible to attach any error term to the estimates, nor is it possible to detect any clear pattern of over or underestimation (but several FDMs referred specifically to the fact that they had been cautious and underestimated the figures quoted).

The overall total for Great Britain shows a modest increase over 1977 of 13.3%. Despite the fact that the Conservancy estimates obtained in 1977 are subject to uncertainty, there is nevertheless very marked and sometimes dramatic variation between Conservancies. The increase of 78% recorded in the New Forest is reasonably well documented (Forestry Commission, 1987b). More modest increases or decreases shown for SW England, N Wales, E Scotland, SE England, W Scotland and N Scotland do not immediately raise suspicions of error. However, the very large increase shown for NW England (174%) and decreases shown for NE England, S Wales and S Scotland are more surprising. Several factors, in addition to errors in estimation, will contribute to any changes recorded between 1977 and 1987/88.

Table 8.1 Summary of District Managers' estimates of day visits to the Commission's estate in 1987/88; Conservancy boundaries are as at 1977 to allow comparisons.

Conservancy	*1977 (000s)*	*1988 (000s)*	*Change 1977/1988*
NW England	777.6	2127.0	+174%
NE England	2100.0	1251.0	–40%
E England	2108.9	3110.0	+47%
SE England	2108.7	2500.0	+19%
New	4506.3	8000.0	+78%
SW England	3014.1	3858.1	+28%
N Wales	943.2	1179.5	+25%
S Wales	2539.8	746.0	–71%
S Scotland	1154.4	450.0	–61%
E Scotland	975.0	1119.0	+15%
W Scotland	1218.8	1047.5	–14%
N Scotland	2158.7	1368.0	–37%
	23 605.5	26 756.1	+13%

Major causes of variation are due to the methods and accuracy of the estimates produced by individual Forest District Managers. Those Forest Districts with a visitor centre, major car park, forest drive or other monitored attraction are usually able to provide a good estimate, often over a period of several years. In other Forest Districts, or remote areas of Forest Districts, the figures can be no better than rough estimates based on casual observations made by Forestry Commission staff. An analysis of the intensity of use (of car park spaces) implied by the estimates (see Benson and Willis, 1990) provides some sense of the possible accuracy (or otherwise) of the estimated figures.

The actual assumptions used by Forest District Managers are also a potential source of

Table 8.2 Volume of trips to the countryside: numbers of trips per person in each 4-week period surveyed.

Month	*1977*	*1980*	*1984*	*1985*	*1986*	*1987*	*1988*
February			2.5	2.0	2.0	2.2	2.13
May			4.3	3.7	3.4	3.5	no data
June			4.4	4.0	4.2	3.4	3.95
Summer (4 weeks)	2.5	1.6					
July			6.0	4.1	4.6	3.8	4.38
August			5.9	4.9	5.0	4.1	5.00
October			3.6	2.4	2.7	2.4	2.94
Monthly average			4.5	3.5	3.7	3.2	3.68

Source: Countryside Commission (1987): A compendium of recreation statistics (1984–1986) with 1988 addendum.

'error'. It is clear that some have interpreted a forest visit only as a specific visit to a piece of Forestry Commission land or special attraction. For example, the estimate for Kielder Forest District (132 000) is based on monitored use of the visitor centre and the assumption that this represents about one-third of visits to the forest. A much larger number of people visit 'Kielder' and in particular Kielder Water which is set within the forest (around 250 000 to the Northumbria Water Visitor Centre and perhaps 500 000 or more to the reservoir zone). The forest existed before the reservoir and provides an important part of the overall landscape setting, but visitors would still come to the reservoir without the forest. It is impossible to suggest which visits, or what proportion of the total to the area, should be attributed to the forest and which to the reservoir. In the case of Kielder Forest District the estimate for forest visitors is cautious and probably a minimum figure. Similar comments would apply to other estimates such as those for Newton Stewart, Aberfoyle and Castle Douglas.

Other data sources

In order to try to gauge the accuracy of the estimates of visitor numbers it is necessary to examine the trends in general recreational use of the countryside as a whole, and to examine what percentage of total recreational visits may be made to Forestry Commission land.

Data from the Countryside Commission (England and Wales)

The first set of data comes from the Countryside Commission who have carried out National Countryside Recreation Surveys in 1977, 1980, 1984, 1986 and 1988. The monthly averages for trips per person per 4-week period surveyed are shown in Table 8.2. On the assumption that the same conversion factors apply from year to year, the total approximate numbers of trips implied by the surveys are shown in Table 8.3. The approximate overall change implied during the period 1977–87 is more than +100%. Note, however, the wide fluctuations suggested, from a low in 1980 to a high in 1984. By comparison, the Forest District Managers' estimates suggest

Table 8.3 Countryside trips 1977–1988 (England and Wales): approximate estimates.

	Total trips per annum (all trips: millions)	*Total trips per annum (3 or more hours: millions)*
1977	550	–
1980	352	–
1984	2000	1500
1985	1555	1166
1986	1644	1233
1987	1422	1067
1988	1635	1012
mean 1984-88	1651	1196

1977/80: age 16+; 1984– : age 12+
Source: Interpreted Countryside Commission data.

a change on the Forestry Commission estate of +13% during the period 1977–1987/88.

Data from the British Tourist Authority (Great Britain)

A second set of data comes from the British Tourist Authority (BTA) (1988). As the survey include samples of all leisure activities such as cinema, restaurant, disco, casino visits, etc., as well as indoor sporting activities, it is necessary to abstract only those categories of activity which correspond with those of the Countryside Commission surveys in order to make comparison possible; note that this is only approximate. Data on trips in the BTA survey are also recorded by 'main type of area' visited. Note again, however, that the match with Countryside Commission data cannot be exact. Two estimates for the total annual number of trips in 1986 (broadly countryside) are therefore obtained (Table 8.4).

Summary of data (England and Wales)

A comparison between the Countryside Commission and British Tourist Authority surveys is only possible for 1986. By making certain assumptions about the duration of trips and the ages of respondents, the following comparative figures are obtained for all countryside trips of 3 or more hours: Countryside Commission 1480 millions, British Tourist Authority 1104 millions (by activity) and 1249 (by area). The figures are of the same order, but the reasons for differences include several simplifying assumptions used (for both data sets) and definitional problems on trip destinations. In view of these factors it is perhaps of some significance that the results, from two independent surveys, are in very broad agreement that countryside trips in 1986 numbered between 1.1 and 1.5 billions.

The overall trend since 1977 can only be assessed in the light of the Countryside Commission surveys which, at least since 1984, are comparable. Visits in 1984 were very high in comparison with the years since and perhaps those before also. Figures for the late 1980s have fluctuated and show no clear trend in either direction, but the figures do suggest some significant overall growth since 1977.

Table 8.4 Countryside trips in 1986.

Millions of trips of 3 or more hours	
All leisure trips (UK)	3121
Countryside trips (by main activity)	1225
Countryside trips (by main area visited)	1424

National breakdown:	*Total all leisure*	*Countryside (activity)*	*Countryside (area)*
England	2652	1044	1158
Wales	147	61	91
Scotland	322	105	153
Total	3120	1210	1402

Note: discrepancies between figures are due to rounding and to visits by residents in Northern Ireland, Isle of Man, etc.
Source: abstracted and interpreted from British Tourist Authority (1988).

Trends for Scotland

The Scottish Leisure Survey 1981 estimated a total of 40 million countryside trips during May to September. The annual total was likely to be up to half as much again, at approximately 60 million. The Scottish Day Trip Surveys of 1987, 1988 and 1989 (Countryside Commission for Scotland, 1990) estimate that some 150 million leisure day trips (3 or more hours) are made by Scottish residents, and somewhere between a quarter and a third of these are to the countryside. Countryside trips therefore totalled approximately 48 million in 1987, 35 million in 1988 and 42 million in 1989. The figures reflect significant growth since the early 1970s, but are of a similar order to those recorded in 1981. The total estimates differ significantly from those of the British Tourist Authority and are also different (in relation to population size) from Countryside Commission figures for England and Wales.

Trips to woodlands and forests

Problems of definition

There are no precise definitions of what constitutes a wood or a forest, or a visit to either, even in detailed survey and research work; all the

figures obtained from surveys are therefore for visits to what respondents perceive to be woodland or forest. Also, it is not always clear from the surveys how trips which involve several visits or stopping places are handled. It is therefore important to note that not only will public perception of a woodland or forest vary considerably, but also that as a consequence it is likely that some visits to places like country parks, National Trust properties and picnic sites will also be recorded as a woodland visit, while others will not.

Proportion of visits to woodland and forest

The Countryside Commission survey in 1977 recorded that woodland was the main stop for 3% of trips (Countryside Commission, 1978) but 4% is quoted in Countryside Commission (1979); during the survey in 1984 this had increased to 6%. These estimates are likely to be absolute minima, depending upon the definition adopted for a woodland visit. If a figure of 3% to 6% has been constant throughout the period of the Countryside Commission surveys, the approximate annual totals for all visits to woodland in England and Wales (from Table 8.3) are in the range 52–144 million during the 1980s. Trips in the British Tourist Authority survey (1986) recorded as explicitly to woodland are approximately 32 million for Great Britain.

The estimate by Forest District Managers for visits to Forestry Commission land in 1987/88 (England and Wales) of around 23 million suggests an increase over 1977 of around 27%. In contrast, the Countryside Commission data over the same period implies an increase in visits to all woodland of between 100% and 200% depending on whether a change from 3% to 6% of all countryside visits is real or whether it involves definitional changes. The British Tourist Authority data (1986) appear low in comparison with Forestry Commission estimates.

In Scotland the Leisure Survey of 1981 recorded that 6% of trips were to woodland; the day trip surveys in 1987–1989 recorded a figure of 8%, while the BTA survey (1986) only recorded 1.44% of countryside trips as mainly to woodland. Definitional differences and other problems of comparability mean that the latter figure is undoubtedly too low. The Scottish Tourism and Recreation Study (Tourism and Recreation Research Unit, 1978) found that 7% of groups interviewed had visited a woodland during a day trip of at least 2 hours, but this figure cannot be translated into the proportion of all trips made.

From the latest household surveys, described briefly in the next section, the total for visits to Forestry Commission land in Scotland (2+ million) is 4–6% of the total for countryside trips estimated for 1987–1989. This figure of 2+ million is also comparable with the Forest District Managers' estimate of approximately 4 million (Table 8.1).

Household survey results

The Forestry Commission and other agencies have recently commissioned a survey of visits to woodlands and forests based on household interviews during 1987, 1988 and 1989. The estimate for all visits to woodland and forest in Great Britain is approximately 114 million, including 38 (or up to 47) million to the Forestry Commission estate; these figures are high in comparison with the previous figures quoted from the British Tourist Authority survey (1986), but broadly similar to the estimates made using the Countryside Commission surveys. For example, the Countryside Commission survey of 1984 estimated around 2 billion countryside trips, of which at least 6% (120 million) were to woodland as the main stop. The household survey figure of 114 million is very similar, although for a later period and for Great Britain. For Scotland and England and Wales the household survey and Forest District Managers' estimates are inconsistently different (2+ and 4 million, Scotland; and 36 and 22 million, England and Wales).

General conclusions on visitor numbers

The preceding analysis shows significant differences between various independent estimates for the total numbers of visits to the countryside

and to woodlands and forests. Some differences obviously arise from differences in the definition of what precisely constitutes a 'countryside' trip in comparison with other 'leisure' trips. Others are due to imprecision in the definition and interpretation of what is a 'woodland' or a 'forest'. There is no good time series data available to show whether the proportion of trips to forests has changed in relation to other destinations, nor is there trend data on the total share of forest trips which are to the Forestry Commission's estate. The estimates by Forest District Managers are clearly subject to large potential errors because they are mainly based on best guesses rather than detailed monitoring. These possible areas of error mean that all figures can only be regarded as general estimates.

The evidence from the Countryside Commissions' surveys, the British Tourist Authority survey and the Forestry Commission household surveys suggests that the overall Forest District Managers' estimate of around 27 million to the Forestry Commission estate is probably an underestimate. These figures from the Forest Dstrict Managers have, however, been used to gross-up the consumer surplus estimates (see Chapter 9). The final estimate for aggregate consumer surplus is therefore very conservative and represents the minimum benefits likely to be currently generated by informal recreation on the estate. It is also possible that many of any additional visits made to the estate will be of short duration and/or on foot; while such visits are undoubtedly valuable to those who make them, particularly so because they seem to be numerous, they will not generate consumer surpluses as large as those estimated from the surveys described in this report.

Chapter 9

Valuing the Estate

Introduction

The procedure adopted to produce an overall estimate of the non-priced recreation value of the estate is now simple and straightforward. The separate figures for consumer surplus per visit for each cluster are multiplied by the estimated number of visits to produce a cluster total, which can then be summed to produce an overall annual total for Great Britain.

Results

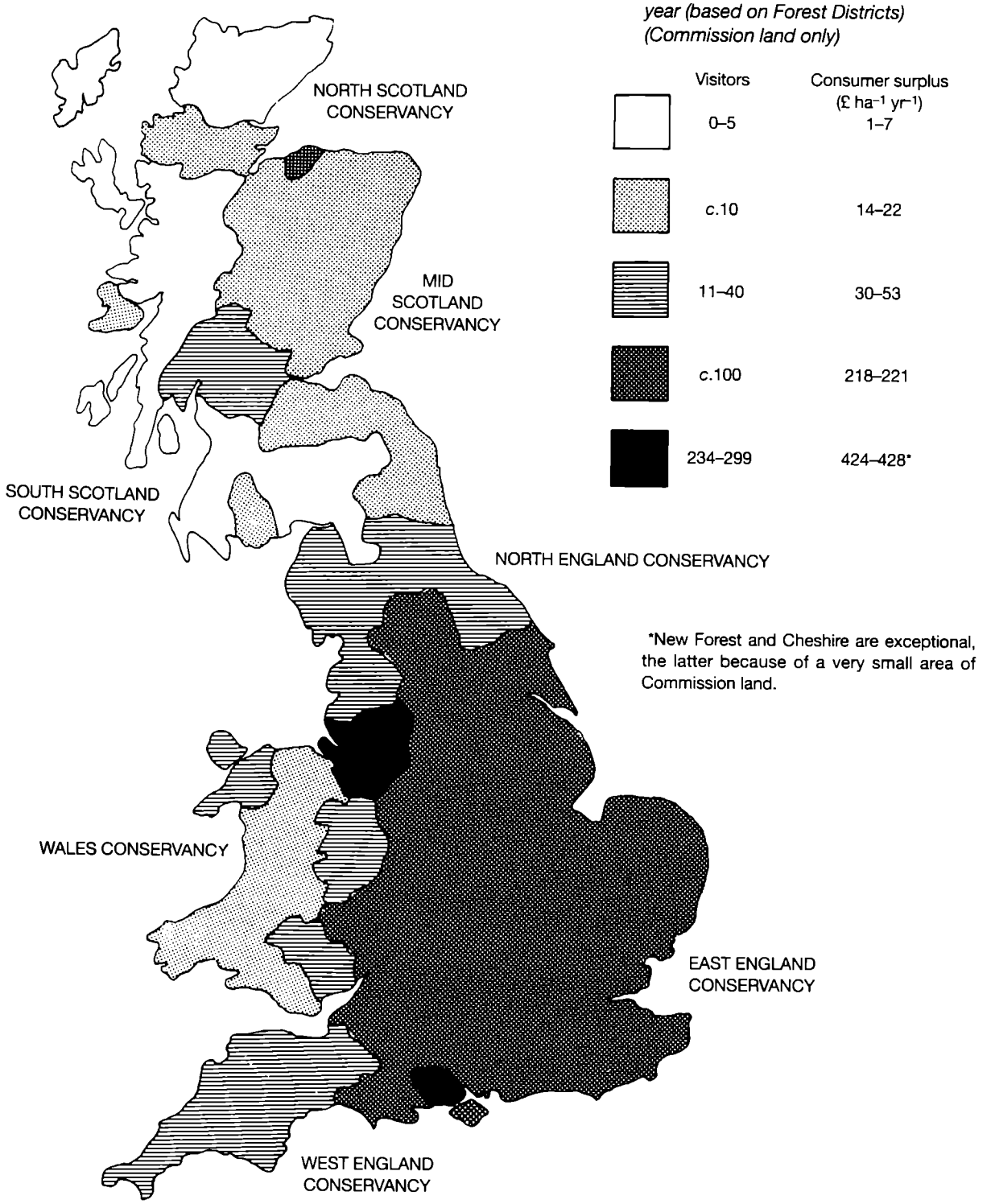
The results of this calculation are shown in Table 9.1. The wide variation in consumer surplus per visit has already been described in Chapter 7 and is discussed further in Willis, Benson and Whitby (1988) and Willis and Benson (1989a). The total consumer surplus value for the estate in Great Britain is approximately £53 million at 1988 prices, with an average value of £47 ha^{-1}, but the value per hectare shows considerable variation about this mean. The overall total of £53 million is very much larger than the estimate of £10 million quoted by the NAO (1986), and is also thought to be a very conservative estimate for the reasons discussed at the end of Chapter 8. The capitalised value of the estate for informal recreation is therefore £883 million at 6% (£787 ha^{-1} on average) compared with a value of £200 million (at 5%) quoted by the National Audit Office.

Table 9.1 Calculation of total consumer surplus values in each cluster of districts.

Cluster	*Number of Districts*	*Consumer surplus (£) per visit*	*Total ha (000s)*	*Total visits (000s)*	*Consumer surplus ha^{-1} (£)*	*Total consumer surplus (£000s)*
1	1	1.43	27	8000	424	11440
2	1	1.91	1	224	428	428
3	1	3.31	34	10	1	33
4	1	2.60	8	150	49	390
5	13	2.26	217	2137	22	4830
6	4	1.79*	45	1154	46	2066
7	2	2.72	59	650	30	1768
8	5	1.34	47	1855	53	2486
9	8	1.61	235	294	2	473
10	5	1.44	156	740	7	1066
11	4	2.41	110	652	14	1571
12	7	2.52	68	561	21	1414
13	8	2.24	57	5621	221	12591
14	7	2.66	57	4678	218	12443
Totals/ means GB	67		1121	26726	47	52999

* mean of two sample Districts.
Figures are rounded.

Figure 9.1 *Variation in visitor numbers and consumer surplus per hectare per year (based on Forest Districts) (Commission land only)*



*New Forest and Cheshire are exceptional, the latter because of a very small area of Commission land.

The total value attributed to individual clusters varies, of course, because of the different sizes of clusters as well as variations in cluster characteristics. Of more interest is variation in consumer surplus per hectare. This is illustrated in Figure 9.1 and used in Table 9.2 to produce a ranking of the clusters.

The very high values at the singleton New Forest and Cheshire Forest Districts are conspicuous at more than £400 ha^{-1}, although in Cheshire this seems to arise because Delamere Forest is relatively small and is the Forestry Commission's only land in the Forest District. The next pair of clusters (13 and 14 containing a total of 15 Forest Districts) also have high values per hectare; these Forest Districts are exclusively in England (except Moray) and contain mainly lowland forests, close to large population centres, but representing a mixture of forest types including relatively higher proportions of older crops of both broadleaves and pines. The recreational benefits outstrip timber values and in parts of many of the forests timber production is secondary to recreation, amenity, landscape and wildlife interests. Public use of the forests is high, exceptionally so in many cases.

At the other extreme, clusters 3, 9 and 10 (14 Forest Districts in total) have very low values per hectare, and are exclusively in the north, west and Border regions of Scotland. Although there is public use of the forests, sometimes at a relatively high intensity in specific locations, the average recreational benefits are very low and would add little to the net present values or internal rates of return calculated for the forest rotations.

In the centre of the ranking (36 Forest Districts) it is less obvious where contrasts should be drawn. Clusters 4, 6, 7 and 8 (12 Forest Districts, consumer surplus range £30–53 ha^{-1}) include six Forest Districts which are located in whole or in part in National Parks (especially clusters 4 and 8), for example the Lake District, North York Moors, Snowdonia, Brecon Beacons, Exmoor and Dartmoor, as well as including Forest Parks such as Snowdonia, Queen Elizabeth, Grizedale and North Riding.

The remaining clusters (5, 11 and 12) include large areas of Wales and other areas mainly in north and east Scotland, but at lower elevations and with older crops than those areas with the very lowest consumer surplus values.

It should be emphasised that there is no direct evidence from these results to link variations in consumer surplus per hectare to forest structure or composition. The variation in consumer surplus per hectare between clusters is more a consequence of variation in visitor num-

Table 9.2 Clusters ranked by consumer surplus per hectare.

Cluster number	*Districts in cluster*	*Sample District*	*Consumer surplus ha^{-1} (£)*
3	1	Loch Awe	1
9	8	Newton Stewart	2
10	5	Lorne	7
11	4	Castle Douglas	14
12	7	Ruthin	21
5	13	Buchan	22
7	2	Aberfoyle	30
6	4	Durham North York Moors	46
4	1	Brecon	49
8	5	South Lakes	53
14	7	Thetford	218
13	8	Dean	221
1	1	New	424
2	1	Cheshire	428

Table 9.3 Clusters ranked by visitors per hectare.

Cluster number	*Districts in cluster*	*Sample District*	*Visitors ha^{-1}*
3	1	Loch Awe	0.3
9	8	Newton Stewart	1.2
10	5	Lorne	4.7
11	4	Castle Douglas	5.9
12	7	Ruthin	8.2
5	13	Buchan	9.8
7	2	Aberfoyle	11.0
4	1	Brecon	18.9
6	4	Durham North York Moors	25.6
8	5	South Lakes	39.5
14	7	Thetford	82.1
13	8	Dean	98.6
2	1	Cheshire	224.0
1	1	New	296.3

bers (because of differences in population density and accessibility) than of a variation in consumer surplus per visit. This is demonstrated in Table 9.3 which shows almost the same ranking of clusters on the basis of visitors per hectare as consumer surplus per hectare. Similarly, there is no evidence to link consumer surplus per visit with forest structure or composition – and the Loch Awe result would suggest that location is likely to be a more important factor.

Chapter 10

Discussion and Conclusions

Recreation in the countryside generates a wide range of benefits to society; these may be personal, social, psychological or economic (Kelly, 1983). Recreation has grown dramatically in the past, but more recent growth and future projections suggest a slower but still positive rate of change. Recreation is also extremely diverse and any assessment of the role of forests and woods must be seen as part of a wider, changing market for the use of leisure time. Although the overall level of informal use is not expected to change dramatically in the near future, there could be marked changes in more specialised pursuits, and in informal use over the rotation period of typical commercial plantations. Forests provide a broad range of opportunities for such uses, particularly because of their ability to absorb large numbers of people and to screen activities both physically and perceptually.

The Bulletin describes a preliminary calculation of the value of non-priced recreation on the Forestry Commission estate. The average (weighted mean) consumer surplus per person (or net benefit) was £2 at 1988 prices; this varies across the estate from £1.34 to £3.31. Although the estimates are sensitive to assumptions made about the costs of travel and leisure time, it is argued that the figures are realistic for day trips by car when compared with the public's valuation of travel costs, and in comparison with entry charges at properties such as those of the National Trust and Department of the Environment, which often include parks, gardens, woodlands and forests.

The key to translating the individual results from the sample surveys to an aggregate total for the whole estate is data on the total number of visitors and the variation between different Forest Districts. Recent estimates for the number of visits to the estate are available from two main sources. During the present project each Forest District Manager has made estimates for individual Forest Districts which are summarised in Table 8.1. The overall estimate for 1987/88 of 27 million is 13% greater than the estimate of 24 million made during a Forestry Commission survey in 1977. The second source is a household survey currently being carried out and evaluated by the Forestry Commission. The overall estimate from this survey is 38 (or up to 47) million. The large discrepancy is potentially due to a diverse and complex set of factors. For example, the Forest District Managers' estimates are more often rough estimates because the monitoring carried out is confined, for obvious reasons, to key sites such as visitor centres and major car parks. The household survey results are based on what respondents perceive to be a visit to a woodland or forest, which may not match the definition used by Forest District Managers in making their own estimates.

For these reasons, the calculations made in Chapter 9 are based on the Forest District Managers' estimates on the grounds that these appear conservative and that caution is wise in the light of the discrepancies outlined above. Despite a small number of estimates for individual Forest Districts which appear (superficially) to be either too high or too low, an analysis of Forest Districts within different clusters (Benson and Willis, 1990) shows a broad measure of agreement for similar Forest Districts; this suggests that the aggregation exercise should result in a consistent pattern of undervaluation. Also, it is possible that any major un-

dercounting which occurs will mainly involve visits of short duration, perhaps on foot and of a local character.

The aggregate value calculated for non-priced recreation is £53 million at 1988 prices, with an average value of £47 ha^{-1}, but a wide variation across the estate (Figure 9.1). The total is much larger than the estimate of £10 million quoted by the National Audit Office (1986).

The present project points to several areas for further research which have already been discussed in previous reports (Willis, Benson and Whitby, 1988; Willis and Benson, 1989a; Benson and Willis, 1990).

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