Valuing and Mapping Woodland Access Potential

by

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Summary

A statistical model of the number of visits to a surveyed woodland is developed and used to predict arrivals at a set of unsurveyed woodlands. Tests show that the model provides acceptable estimates of the actual number of arrivals. The model is then used to predict visitor numbers over a large area (the entirety of Wales) so as to produce a map of recreation demand for this area. Such a map is readily compatible with other analyses allowing a decision maker to identify optimal locations for the establishment of new woodlands.

1. Background

The number of people who visit woodlands for recreation, and the value which those individuals derive from such visits are issues which have exercised government departments, agencies and academics alike for many years (e.g. H.M. Treasury, 1972; Willis et al., 1988; Benson and Willis, 1992). Most the of research undertaken to estimate recreation values has adopted one of two techniques, both of which employed surveys of visitors to collect necessary information. The first was the 'contingent valuation' (CV) method (Mitchell and Carson, 1989). Here visitors were typically asked questions concerning the amount that they were willing to pay for visits to woodlands. While simple in principle, the CV method requires considerable study design expertise to ensure that the values stated by survey respondents corresponds just to a woodland visit rather than to some wider environmental asset (e.g. all outdoor recreation) and provides an unbiased estimate of the amounts that respondents really would pay in a non-survey situation (Bateman and Willis, 1999). Nevertheless, when carefully designed and appropriately executed CV studies can provide useful estimates of the values under investigation. The second approach, known as the travel cost (TC) method (Freeman, 1993), infers visitors recreation value by examining the travel

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This paper is based on a talk given at the N.D.G. James Memorial Conference on *Access to Woodland: Treats and Opportunities*, which was organised jointly be the RFS and the RASE, National Agricultural Centre, Stoneleigh Park, Warwickshire, 9th March 2000.

expenditure (e.g. petrol costs) and amount of time which visitors give up in order to enjoy woodland recreation. Theoretical expectations and a burgeoning empirical literature show that as these travel costs increase so the number of visits an individual makes to a given woodland declines. By examining this relationship the analyst can infer the value which a visitor obtains from an individual woodland visit. Again the method is not as straightforward in application as it might sound in theory. For example, visits are influenced by other factors than just travel costs (e.g. the attributes of the site in question, the availability or otherwise of substitute sites, the incomes and other socioeconomic characteristics of potential visitors, etc). However, as with the CV method, careful design and execution of TC studies can yield acceptable estimates of woodland recreation values.

The studies mentioned previously were primarily concerned with estimating the total recreational value of the Forestry Commission estate and were principally conducted as part of a wider accounting exercise to determine the optimal level of grant aid to the Forestry Commission. However, from the early 1990s to the present day policy has steadily evolved with recreation moving towards the top of the agenda (Forestry Commission, 1991, 1999; Forestry Commission and Countryside Commission, 1996, 1997; England Forestry Strategy, 1998). At the same time the focus of attention has moved from considering the entire estate to looking in detail at individual woodlands in an attempt to optimise the management of existing forests and the planning of new woods. Valuation studies are well suited to such exercises as they explicitly incorporate the characteristics and attributes of the individual woodland into the analysis of visit values. However, this change in policy focus raised the profile of two long recognised but under-researched issues. The first of these was the simple observation that the number of woodlands precluded the possibility that individual survey research exercises such as CV and TC studies could be carried out in every case; the costs of such studies both in terms of money and time would simply be too high. The solution to this problem was, in principle at least, to develop new transferable approaches to CV and TC. The second problem was simply that estimates of the number of people visiting woodlands were very unreliable and based on a paucity of data. This induced a degree of uncertainty into the process of calculating aggregate recreation values which was considerably larger than that associated with any errors in the CV or TC estimates of the value of a recreational visit. Recognising this problem the Forestry Commission substantially expanded its efforts to gather visitor number data during the 1990s with the result that progressively improved estimates of visit rates became available as the decade progressed.

The research reported in this paper combines information on visitor totals with CV and TC surveys of visitors designed so as to produce models of recreation value which are transferable across sites. We start by describing a survey of a particular site in Thetford Forest and then move to discuss a larger study of visit numbers and values for a selection of forests. This exercise provides validation of the approach taken and we extend our research by presenting an analysis of predicted visits and recreational values for a large area (the entirety of Wales) which examines all possible locations, both currently afforested and not, to assess optimal locations for new investments in recreational woodlands. The paper concludes by highlighting ongoing complementary research concerning the timber and other values of forestry and competing land uses.

2. Estimating recreational visits and values for an individual woodland site

Our investigation used data collected as part of a joint TC and CV survey of 351 visitor parties to Lynford Stag, a site in Thetford Forest, East Anglia (full details in Lovett et al., 1997). Respondents were asked about factors influencing their decision to visit the forest and to give details of their journey to the site, including the starting point of their journey that day. This information was then used to build up a 'model' (i.e. a statistical representation) of the factors influencing an individual's decision to visit a particular forest.

A geographical information system (GIS; a computer program capable of storing, processing and displaying any type of digital information which has a spatial reference) was used to map out the journey origins of visitors and relate this to the road distance and travel time to the site. This provided the basic information from which travel costs can be estimated however, as noted previously other factors such as income levels and the availability of recreational substitutes also influence visits. Here we encounter a problem if we wish to build a model which is readily transferable to other woodlands. Although we have information from surveyed visitors regarding these other factors (e.g. their household income, etc.) if we rely upon this information then separate surveys will have to be conducted at each of the woods to which we wish to transfer our models; thus defeating the very object of the exercise. To address this problem it was decided to try and produce a model which relied solely upon information which could be gathered for the whole country. In essence, rather than looking at the defining characteristics of individuals as predictors of the number of visits they make, instead we examine the characteristics of geographically and socio-economically defined groups of people and see whether these can adequately explain visits. If this is the case then the models obtained should be transferable to different areas of the country and by adjusting for the differing characteristics of those various regions we can estimate the numbers of visits likely to be made by people in those locations.

To implement this approach the GIS was used to extract information on socioeconomic factors (such as unemployment levels, car ownership, etc.) from the UK Census and to obtain information on potential substitutes (e.g. the location of other woodlands) from satellite imagery, Forestry Commission records and the Bartholomew digital map database (which also provided information on the road network). We then divided the area from which visitors originated (roughly the entirety of East Anglia) into approximately 100 'zones' within which the socioeconomic circumstances of individuals and their access to substitute sites was roughly constant (although of course these could vary quite substantial between zones). The number of visitors from each zone was then compared to the population of the zone (obviously expected to increase the number of visits); their socioeconomic circumstances; the availability of substitutes (measured as the distance to other woodlands; a factor expected to be negatively related to the number of visits at the forest under investigation); and other relevant factors. Table 1 lists some of the variables defined for relating the number of visits from a zone to a given forest to the characteristics of that zone.

INSERT TABLE 1 HERE

Equation (1) represents the best fitting model derived via the statistical techniques of multiple regression (Wonnacott and Wonnacott, 1990) from this information for all the rural zones included in our East Anglian study area:

$$\text{VISITS} = 3.88 + 0.92\ \text{POP} - 3.52\ \text{TTIME} - 0.0019\ \text{SUBS} + 0.62\ \text{UNEMP} \qquad (1)$$

The number (known as a coefficient) shown in front of each variable describes the impact of that variable upon the numbers of visitors from each zone. So, for example, the coefficient on the POP variable quantifies the positive relationship between the population of a zone and the number of people who travel from it to the woodland under investigation. This is offset by the TTIME variable as here the coefficient shows the negative impact of increasing travel time upon the number of visitors from a zone to the woodland in question. Similarly as the availability of substitutes (SUBS) increases so the number of visitors declines. Finally we see that as the rate of unemployment (UNEMP) in a zone increases so does the number of woodland visits. This latter result may signify a variety of factors but one straightforward inference may be that the unemployed are more likely to visit free, open-access, resources such as woodland than are the employed (who may have a wider range of recreational possibilities open to them). This highlights a potential distributional aspect to woodland recreation benefits. In summary then, Equation (1) tells us that the number of visitors from any zone to the woodland in question increases with the population of that zone, decreases the further that zone is from the woodland or the greater the number of alternative, substitute woodlands that are available and increases with the proportion of unemployed in the zone (although this latter variable may in fact by a proxy for a number of related factors; see Lovett et al., 1997, for discussion).

Analysis showed that visitors from relatively major urban areas behaved slightly differently from those in rural areas in that the availability of substitutes had a somewhat larger impact upon the number of visits made to our study site. However in other respects they were the same as rural visitors.

This information was then combined with further data, provided by the Forestry Commission (see details in Bateman, 1996), on the pattern of visits over the year such that both visit numbers and recreational values could be estimated. Tests showed that our approach provided good predictions of the annual arrivals totals which were within 5% of the actual number of visitors (*ibid.*).

3. Transferring estimates of recreational visits and values across different woodlands.

In order to test the transferability of our models to other sites a set of some 33 British woodlands were selected for which the Forestry Commission held estimates of annual visitor arrivals (further details in Brainard et al., 1999). In order to use our models to predict arrivals to these sites, further variables were added detailing several quality characteristics of each woodland, e.g. the length of woodland walks, whether cycle hire facilities were available, etc. These extended models were then used to estimate annual arrivals at the sites (*ibid.*). The model worked poorly for three woods which were all contained within the same forest. However, at other sites our estimates provided a reasonable approximation of actual arrivals with 60% of predictions being within 25% of recorded arrivals and 73% being within 50% of recorded arrivals. Given that the Forestry Commission recognise that their own estimates are subject to inaccuracy this seemed a reasonable result. Table 2 indicates results from this exercise with recreational benefit values being derived via the TC method.

INSERT TABLE 2 HERE

4. Predicting visits and values across large areas: A GIS based forest planning approach

The research described above provides estimates of the demand for forest recreation at specified sites. However, we can also apply our models to all possible locations for existing and new woodlands across a large area. In so doing we can identify which locations are likely to attract the most visitors and generate the highest recreational values. Such an exercise was carried out for the entire area of Wales. The GIS was used to capture spatial information such as the road network and the distribution of population (both types of date were collected for an area very substantially greater than Wales to allow for English visitors to Welsh sites). These data were then fed into our models to predict recreational arrivals for each point on a 5km square grid covering the whole of Wales. Values in this case were estimated via the CV method (see details in Bateman et al., 1999a) and are illustrated in Figure 1.

INSERT FIGURE 1 HERE – THE POSTSCRIPT FILE NAME IS: **RASE1.PS**

The grid square estimates illustrated in Figure 1 show the estimated annual value of the recreation visits predicted by our model for a forest (whether existing or planned) located in that square. As might be anticipated, Figure 1 strongly reflects population distribution in the prediction of recreational woodland visits. In south Wales the influence of cities such as Swansea and Cardiff and the densely populated 'valleys' area, results in relatively high visitor predictions. Similarly, in the north-east, the influence of nearby English cities such as Manchester and Liverpool is very clear. Conversely, in mid Wales and western coastal areas, the low population density results in severely depressed visitor arrival estimates. Population impacts tend to be compounded by the distribution of higher quality transport infrastructure. This inflates the already high arrivals numbers generated by the proximity of large centres of population.

5. Conclusions and links to other research

The research discussed in this paper provides an approach for estimating the number of visitors to a woodland and the value of that recreation at both surveyed and non-surveyed woodland sites. Furthermore, we have extended this work to develop a GIS based approach to estimation of potential recreation demand for proposed new woodlands (the method can also be readily adapted to investigate the impact of refurbishing or extending existing sites). Maps such as those illustrated in Figure 1 provide a ready guide to planners and indicate that the recent moves to 'bring forests down the hill' and into high population, lowland areas may be well justified in terms of the recreational benefits generated.

The conversion of visitor arrival estimates (illustrated in Bateman et al., 1999a) to money value equivalents (as per Figure 1) also permits this analysis to be combined with other research we have undertaken into the timber value generated by woodlands (Bateman and Lovett, 1998), carbon storage values (Bateman, 1996) and the opportunity cost of agricultural land used for afforestation (Bateman et al., 1999b). Synthesis of these diverse values permits the land use planner to identify those areas which, on a variety of criteria, provide optimal locations for conversion from agriculture into multipurpose woodland. It is hoped that such research will provide a richer and more accurate basis for policy change and targeting.

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Table 1: A selection of variables used to predict the number of visits from a zone

Variable	*Definition*
VISITS	The number of predicted visits from a zone to the forest under investigation
POP	A measure (the logarithm) of the resident population of the zone
TTIME	A measure (the logarithm) of the average travel time from the zone to the forest
SUBS	A measure of the accessibility of substitute woodlands based upon their distance from the zone
UNEMP	A measure (the logarithm) of the average male unemployment rate in the zone

Table 2: Official estimates and predictions of recreational visitors to 30 woodlands.

Site Name	Official Count	Predicted visits per annum	Recreational value (£, per party visit)	Total recreational value per woodland (£ per annum)
Dunwich	18,980	15,957**	1.56	24,828
High Lodge	14,940	46,925 †	1.33	62,381
Lynford Arboretum	7,101	21,356 †	2.83	60,354
Lynford Stag	42,010	14,745 †	1.91	28,098
Two Mile Bottom	22,636	22,678**	2.72	61,676
Kielder Castle	24,243	56,747	3.57	202,767
Forest Drive	31,641	26,200**	3.57	93,616
Warksburn	3,794	5,351 *	7.42	39,706
Bogle Crag	14,924	47,475	5.38	255,408
Grizedale	85,181	81,015**	3.48	281,824
Noble Knott	7,543	35,407	3.51	124,149
Whinlatter	55,797	60,838**	3.36	204,571
Blackwater	39,338	37,518**	5.19	147,813
Bolderwood	22,963	28,503**	4.86	182,318
Moors Valley	165,552	157,561**	4.14	652,149
Bucknell	21,360	45,526	1.63	74,117
Salcey	77,650	75,644**	2.23	168,735
Wakerley	51,490	42,354**	2.06	87,456
Dalby	130,151	77,804 *	3.31	257,260
Chopwell	42,298	54,251 *	6.36	344,846
Hamsterley	76,796	71,770**	3.50	251,462
Simonside	12,430	32,526	2.94	95,462
Blidworth Bottom	54,547	41,844**	3.15	131,776
Blidworth Lane	52,754	45,103**	3.16	142,394
Blidworth Tower	37,596	45,288**	2.91	131,660
Chambers Farm	23,605	22,808**	1.92	43,836
Goyt The Street	84,279	73,400**	2.63	193,058
Normans Hill	30,936	35,975**	2.66	95,748
Thieves Wood	72,276	45,617 *	2.66	121,474
Sherwood Centre	38,919	42,325**	1.78	75,430

** = predictions within 25% of official estimates
* = predictions within 50% of official estimates
† = Subsites; sites within a larger forest with multiple sites
Values are in 1990 pounds.

Figure 1: The value of predicted woodland recreation demand for locations in Wales (£ per hectare per annum)