SECTION 7

Deforestation Rates in the United Kingdom

Contents

Estimation of UK Deforestation Rates

P.E. Levy and R. Milne
Centre for Ecology and Hydrology, Bush Estate, Penicuik, Midlothian, EH26 0QB, U.K.
6 April 2003

Summary

Estimates of the UK deforestation rate are required for reporting under the UNFCCC GHG Inventory and the Kyoto Protocol. The most direct record of deforestation is provided by FC Felling Licences, which give a value of ~500 ha y^{-1} for recent years. This represents an absolute minimum, as unlicensed felling will occur to an unknown extent. The deforestation rate can be estimated indirectly by constructing a forest area budget, assuming deforestation is the residual term remaining after the observed change in forest area is subtracted from the recorded area of newly planted forest. The total forest area recorded in FC Facts & Figures cannot be used, as it is an estimate partly based on the new planting data, so it's use would be circular. Independent estimates of the total GB forest area can be obtained from the FC Woodland Census, the National Inventory of Woodland & Trees, and the Countryside Survey. An additional independent source of estimates of the total Scottish forest area is provided by the National Countryside Monitoring Scheme (NCMS). The observed increase in total area in these data does not differ significantly from the recorded planting rate, and a statistically significant deforestation rate is not detectable.

An alternative approach is to use national survey schemes, in which repeated surveys of land use are made in a set of permanent plots. Deforestation rate can be calculated as the sum of transitions from all forest classes to all non-forest classes. Both the NCMS and the Countryside Survey can be used in this way. The NCMS survey can be scaled to give a GB deforestation rate of ~1000 ha y^{-1}, whilst the Countryside Survey gives a value of ~20000 ha y^{-1}. The NCMS value is thought to be more reliable, as the afforestation rate estimated in this way agrees closely with FC figures, whilst the Countryside Survey overestimates afforestation by a factor of ~2. Various possible reasons for this discrepancy are discussed, including the effect of minimum plot size and methodological differences such as the urban: rural bias in the sampling design.

Ordnance Survey data can be used in a similar way, but as the whole country is covered by a rolling programme of surveys, sampling bias should be removed. These data show a similar temporal pattern to the Felling Licence data, but with considerably higher deforestation rates, with a mean of 2925 ha y^{-1} and a peak at over 5000 ha y^{-1}. However, these data suggest that there was substantial conversion of forest to agricultural land (62 % of the total deforested area). It seems unlikely that extensive unlicensed felling would have occurred for expanding agricultural land, when there has been little economic or policy incentives to do so, and we therefore suspect that these data overestimate rural deforestation. The best estimate of the recent deforestation rate may be obtained by combining the data from the FC felling licences (accounting for conversions to rural uses) with the OS estimate of deforestation for non-rural uses which do not generally require a felling licence. This gives a value of 1375 ha y^{-1}.

1 Introduction

Deforestation is defined as the felling of trees without subsequent replanting or regeneration – that is, the conversion of previously forested land to agricultural, urban or other land uses, which do not have a substantial tree cover. Estimates of national deforestation, afforestation and reforestation rates from 1990 are required for preparing greenhouse gas inventories for the United Nations Framework Convention On Climate Change (UNFCCC). In the U.K., afforestation and reforestation rates have been recorded by the Forestry Commission since the 1920s. However, deforestation rates have not been recorded, other than Forestry Commission unpublished records of areas granted 'unconditional' felling licences (see below). Whilst the deforestation rate may be negligibly small, there is now a need to provide an explicit quantification. Here, we examine whether this is feasible using existing sources of data.

2 Data sources and methodology

Four methods were used to assess deforestation rates in Britain, averaged over various periods since the 1940s. The first compared estimates of the areas of forest planted in Britain each year with independent estimates of the increase in area of forest on the ground. The second used data on land use change from repeat surveys. The third used felling licence statistics. The final method was based on land use change from national mapping data.

3 Forest Area Budget

In the absence of direct data, the simplest method is to infer deforestation from a budget of the total forest are, ie:

$$\text{Change in Forest Area} = \text{Afforestation} - \text{Deforestation}. \qquad [1]$$

so by simple rearrangement, we can estimate the deforestation rate as:

$$\text{Deforestation} = \text{New Planting} - \text{Change in Forest Area}. \qquad [2]$$

Data for afforestation (new planting) have been published annually in an appendix to the FC Annual Report, 'Facts & Figures'. (Data for the total forest area are also published in this report, but the estimates use the new planting data, and so are not independent.) Independent estimates of total GB forest area are available at approximately decadal frequency from the FC Woodland Census (1940, 1965, 1980 (Smith 2001)), the National Inventory of Woodland & Trees (Forestry Commission 2000), and the Countryside Survey (Barr 1993; Haines-Young 2000; Haines-Young et al. 1996,).

As the accuracy of planting data is expected to be relatively high, the forest area budget method is likely to be limited by the accuracy of the total forest area data. For this reason, we applied a restricted budget method to Scotland, where an extra data source is available through the National Countryside Monitoring Scheme (NCMS) of Scottish Natural Heritage (SNH) covering the 1940s, 1970s & 1980s (Mackey et al. 1999).

4 Observed change in sample plots

Another approach is to make repeated surveys of land use in a set of sample plots. Plots are allocated into some land use classification scheme. For each interval between surveys, the data can be used to produce a land use change matrix, quantifying the transitions between land use classes. Deforestation rate can be calculated as the sum of transitions from all forest classes to all non-forest classes. One such scheme is the

National Countryside Monitoring Scheme (NCMS) of Scottish Natural Heritage (SNH). The scheme recorded land use in 487 1 x 1 km plots, based on interpretation of aerial photographs. Photographs were taken in the 1940s and the 1980s, with a smaller number analysed representing the 1970s. The scheme defines 45 land use classes, six of which are considered to be forest classes (namely: Broadleaved woodland, Mixed woodland, Broadleaved plantation, Parkland, Coniferous woodland, Young plantation, Coniferous plantation, Felled woodland).

A second survey scheme is the Countryside Survey, run by the Centre for Ecology and Hydrology. The scheme established 381 1 x 1 km plots throughout GB, in which land use was recorded by ground surveys in 1984, 1990 and 1998. The scheme defined 11 land use classes, two of which are forest classes (Broadleaved woodland and Coniferous woodland).

5 Felling Licences

In the UK, some activities which involve tree felling require permission from the Forestry Commission, in the form of a Felling Licence, or a felling application within the Woodland Grant Scheme. Under the Forestry Act 1967, there is a presumption that the felled areas will be restocked, usually by replanting. Thus, in the 1990s, about 14 kha/yr were felled and restocked. However, some licences are granted without the requirement to restock, where there is good reason - so-called unconditional felling licences. Most of these areas are small (1-20 ha), but their summation gives some indication of areas deforested. These areas are not published, but recent figures from the Forestry Commission have been collated.

These estimates of deforestation must be regarded as underestimates, because several types of felling do not need permission. Notably, exemptions are granted for young coppice, and for fellings required for building development authorised by planning authorities (covered by the Town and Country Planning Act, 1990), to provide gas, electricity and water services, or to prevent danger or nuisance or the spread of pests or diseases.

6 National mapping data

In the UK, the Ordnance Survey (OS) has a rolling programme of surveys for updating the national mapping data. These surveys are carried out with a combination of aerial photography and ground-based field work. Eleven broad land use categories are defined, with a number of sub-categories. As in the above method, the data were used to produce a land use change matrix, quantifying the transitions between land use classes. Deforestation rate was calculated as the sum of transitions from all forest classes to all non-forest classes.

7 Results

7.1 Forest Area Budget

The observed increase in forest area is shown in Figure 1a, which plots the estimates from different surveys for GB. Linear regressions were fitted to estimate the rate of increase in forest area over different periods. Figure 1b plots the mean rate of forest planting against the observed rate of increase in forest area, showing the 95% confidence interval in the regression slopes and the 1:1 line. Where the points lie below the 1:1 line, deforestation can be inferred. Where the points lie above the 1:1 line, extra afforestation beyond the recorded new planting can be inferred. Three out of four fall in

this latter category. Using these data in equation 2 yields values between -9780 and 2280 ha y-1. However, in all cases, the confidence interval overlaps with the 1:1 line, indicating that the observed increase in total area does not differ significantly from the recorded planting rate. A statistically significant deforestation rate is therefore not detectable in these data.

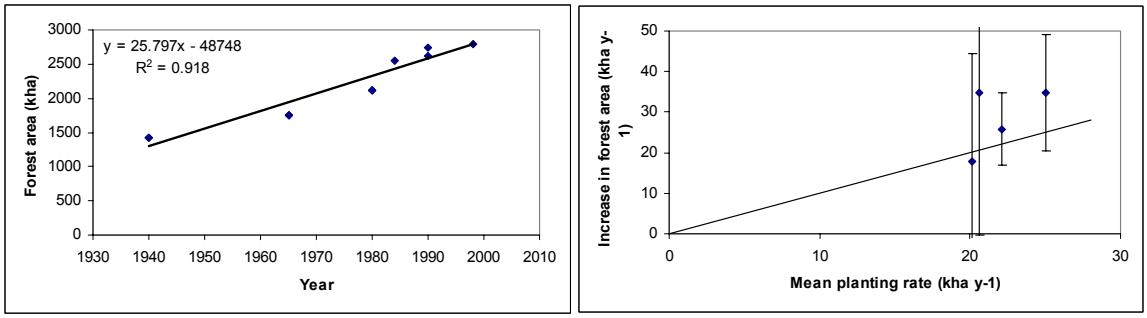

Figure 1 (a) Increase in GB forest area since 1940, from various data sources. A linear regression against time is shown (solid line), giving the mean annual increase since 1940. Three other regressions were calculated, for the periods between the present day and 1965, 1980 & 1984 (not shown). (b) The mean new planting rate over these four periods was calculated from FC 'Facts & Figures' data, and plotted against the observed increase. Error bars show the 95 % confidence interval in the regression slope derived in (a).

The same analysis, applied to data for Scotland, is shown in Figure 2. Using these data in equation 2 yields values between -2290 and 1510 ha y-1, the latter of which scales to a value of ~3000 ha y^{-1} for GB (Scotland contains 49 % of the GB forest area). As in Fig. 1b, the confidence interval overlaps with the 1:1 line in all cases, indicating that the observed increase in total area does not differ significantly from the recorded planting rate, and a statistically significant deforestation rate is not detectable.

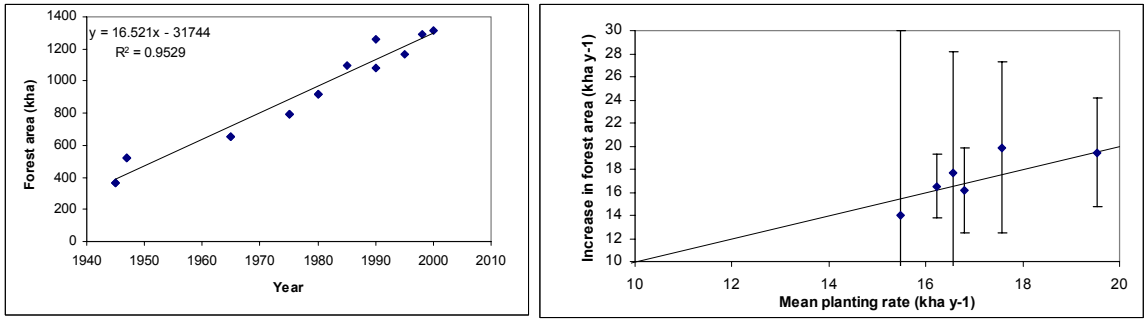

Figure 2 (a) Increase in Scottish forest area since 1945, from various data sources. A linear regression against time is shown (solid line), giving the mean annual increase since 1940. Five other regressions were calculated (not shown), as in Fig 1a. (b) The mean new planting rate over these six periods was calculated from FC 'Facts & Figures' data, and plotted against the observed increase. Error bars show the 95 % confidence interval in the regression slope derived in (a).

As an alternative way of obtaining an estimate of recent deforestation, the Countryside Survey 2000 data were used to give the net change in forest area between 1990 and 1998 (+58 000 ha). This was combined with FC planting data for this period (+137 200 ha), to give an estimate of the deforestation rate of 9900 ha/y.

There are several problems with this method. Most importantly, the accuracy of the deforestation rate estimate depends on the records of new planting and total area, as all the error is combined in the deforestation rate term.

7.2 Observed change in sample plots

The deforestation rate was calculated as the sum of transitions from all forest classes to all non-forest classes in the NCMS data. Over the 1940s-1980s time period of the study, the deforestation rate derived was 460 ha y^{-1}. The corresponding value for the afforestation rate from the NCMS data was 18032 ha y^{-1}. As a check on the method, this latter value can be compared with FC 'Facts & Figures', which gives a relatively similar value of 15803 ha y^{-1}. Making the conservative assumption that forests over GB as a whole experience the same deforestation rate as in Scotland, we infer a GB deforestation rate of 940 ha y^{-1} for this time period (Scotland contains 49 % of the GB forest area, so 460 / 0.49 = 939).

The deforestation and afforestation rates calculated from the Countryside Survey data are around 20 000 ha y^{-1} (Table 1). The deforestation rates are approximately twenty times larger than those based on the NCMS data, and much higher than the highest value obtained by the forest area budget method. Although there are few other data for comparison, we suspect that the CS survey deforestation rates are erroneously high, because the same survey also produces erroneously high afforestation rates (Table 1). The calculated afforestation rates are a factor of 1.5 to 2 higher than corresponding values from FC 'Facts & Figures', the latter of which are expected to be reasonably accurate.

Table 1. Deforestation rates calculated for GB from the two survey schemes. Calculated afforestation rates are also shown, for comparison with the FC 'Facts & Figures' data over the same time period. All values are in ha y^{-1}. *Scotland only.

Survey	Time period	Deforestation	Afforestation	Afforestation FC F&F
NCMS	1940s-1980s	940	18032*	15803*
CS	1984-1990	23750	36250	25306
CS	1990-1998	18353	39263	18942

7.3 Felling Licences

Figure 3 shows the area deforested since 1980. This shows a decrease in the area deforested from around 500 ha y^{-1} in the early 1980s to a minimum of 61 ha y^{-1} in 1997. There follows a sharp increase, peaking at 1332 ha y^{-1} in 1999. Most of this recent loss of forest occurred in England, and partly reflects a recent effort to return forest in parts of southern England to moorland and wetland, in line with EU policy.

7.4 National mapping data

Figure 3 shows the area deforested since 1985 according to the Ordnance Survey data for England. This shows a similar temporal pattern to the felling licence data, but with

considerably higher deforestation rates, with a mean of 2925 ha y^{-1} and a peak at over 5000 ha y^{-1}. In the 1980s, there was an approximately equal division between deforesting for rural uses (agriculture, rough grazing and semi-natural land) and non-rural uses (housing, recreation, minerals & landfill etc.). In the 1990s, there was a dramatic increase in the area deforested for rural uses, whilst the non-rural component remained roughly the same. 62 % of the total deforested area was converted to agriculture (including rough grassland & bracken). These estimates were scaled up to GB scale, assuming that England accounted for 80 % of deforestation to rural uses (from the felling licence data) and 51 % of deforestation to non-rural uses (assuming it scales simply in proportion with forest area).

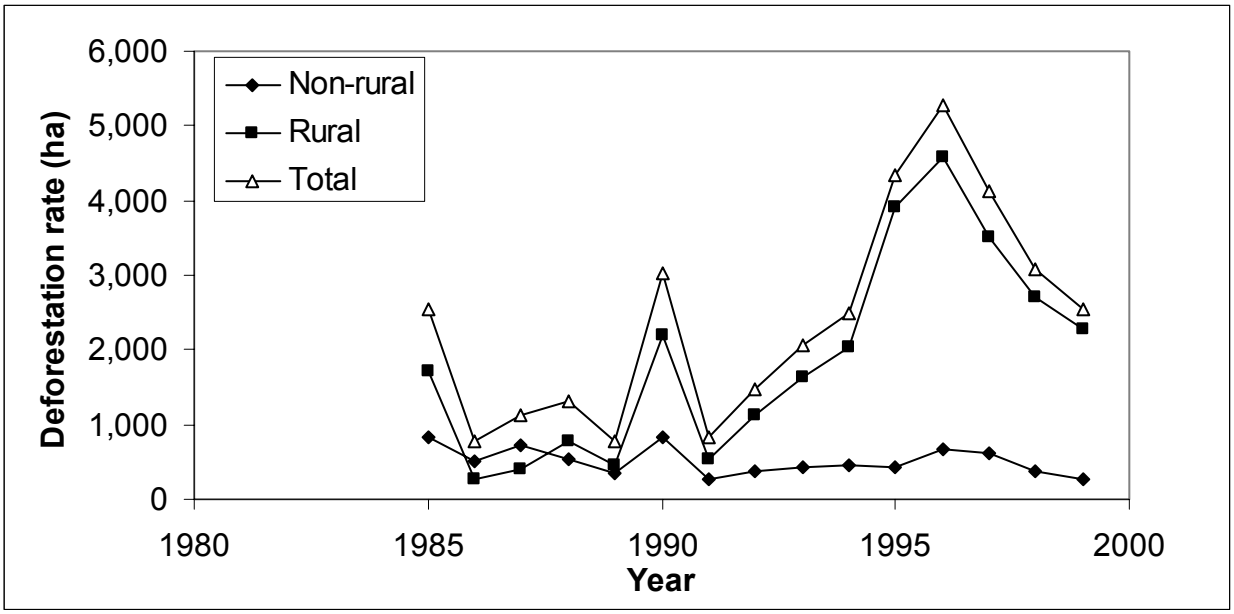

Figure 3 Deforestation rates estimated from the Ordnance Survey national mapping data. Lines show the total deforestation rate, plus the sub-division into land that was subsequently used for rural uses (agriculture, rough grazing and semi-natural land) or non-rural uses (housing, recreation, minerals & landfill etc.).

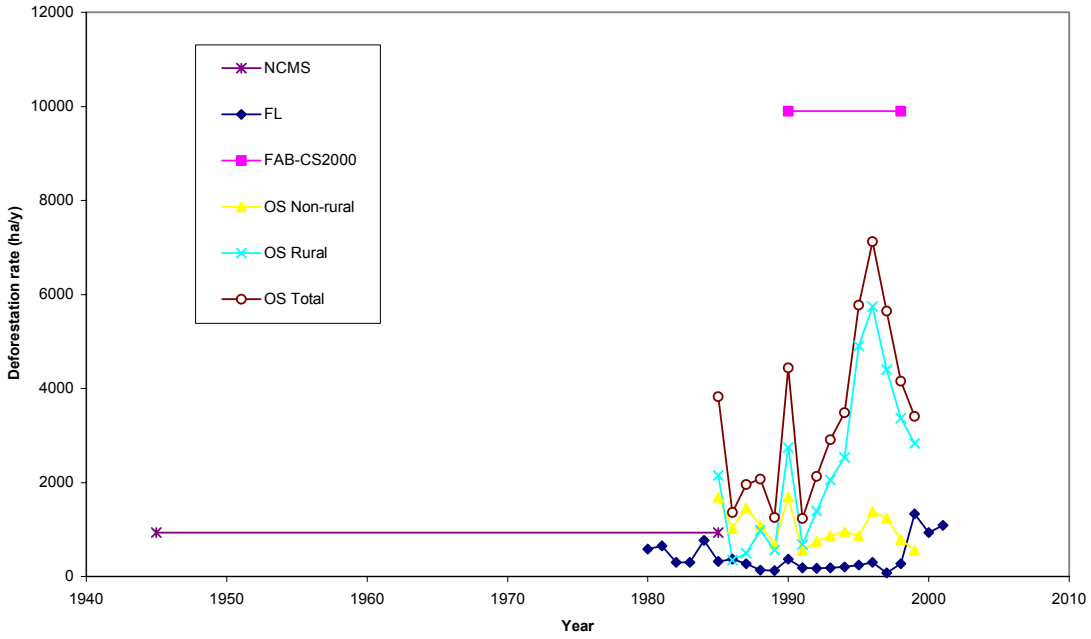

Figure 4. Deforestation rates estimated by the different methods. Horizontal lines indicate the time period over which the estimates apply. NCMS = National Countryside Monitoring Scheme; FL = Felling licences; FAB-CS2000 = forest area budget based on Countryside Survey and FC planting data; OS = Ordnance Survey data, sub-divided into deforestation for rural uses (agriculture, rough grazing and semi-natural land) and non-rural uses (housing, recreation, minerals & landfill etc.).

8 Discussion

There are clear differences in the deforestation rates estimated by the different methods (Table 2, Fig. 4). To summarise the results: the NCMS data yield a deforestation rate of 940 ha y^{-1} for the period between 1940 and 1980. The forest area budget does not detect a significant deforestation rate, but suggests an upper limit of ~3000 ha y^{-1} using the regression method, or 9900 ha y^{-1} in recent years based on the Countryside Survey data. The Countryside Survey sample plot data produce an estimate for the deforestation rate of 18353 ha y^{-1} between 1990 and 1998. Felling licence data give a mean and maximum of 449 and 1332 ha y^{-1} since 1990, whilst equivalent mean and maximum values from the Ordnance Survey mapping data were 4059 and 7119 ha y^{-1} respectively.

Table 2. Summary of estimates of deforestation rate in GB from the different methods. The combined estimate is the sum of the FC felling licence data and the OS non-rural deforestation (see text).

Period	Data source	Method	Deforestation rate (ha/y)	
1940s-1980s	NCMS	Sample plots	940	
1940s-1998	Various	FAB	< 3000	
1990-1998	CS2000	Sample plots	18353	
1990-1998	FC & CS2000	FAB	9900	
1990-2001	FC	Felling licences	449	
1990-1998	OS	Rolling census	926	Non-rural
1990-1998	OS	Rolling census	3133	Rural
1990-1998	OS	Rolling census	4059	Total
1990-1998	FC & OS	Combined	1375	

In the Ordnance Survey data, the large area deforested for agriculture is surprising, as the conversion of woodland into pasture or crops would require an unconditional felling licence, and should therefore show up in the felling licence records. It is possible that the data are accurate, but it seems unlikely that such extensive unlicensed felling would have occurred for expanding agricultural land, when there has been little economic incentive to do so. Indeed, all the policy measures provide incentives in the opposite direction, ie. to take land out of agricultural production under the Set-Aside and Woodland Grant Schemes. We therefore suggest that these may be overestimates of rural deforestation. The best estimate of deforestation may be obtained by combining the data from the FC felling licences (accounting for conversions to rural uses) with the OS estimate of deforestation for non-rural uses which do not generally require a felling licence.

The Countryside Survey scheme data provide the most questionable estimates, which is most parsimoniously explained by differences in classification of land use by different surveyors, several years apart. In all the survey schemes, any errors in classification of land use would produce erroneous land use change estimates. In the NCMS and Ordnance Survey, the earlier photograph or map is readily available for comparison with the more recent one. It is possible that this allows the observer to recognise areas that have not changed more easily, introducing a systematic difference. In the Countryside Survey, the previous survey data is not so readily to hand, and each survey may be done by different surveyors. Differences between surveyors in the application of the classification scheme would give erroneously high turnover rates. This should be quantifiable if different surveyors survey the same sites. Changes in the land use classification used in the Countryside Survey may also play a role.

Both NCMS and Countryside Survey schemes are explicitly directed at the ‘countryside’, and have a bias in the sampling design towards rural areas. However, much deforestation may be at urban edges, and could be missed by the surveys. This could be a systematic difference between survey schemes, depending on differences in

their sampling designs. No such bias should be present in the Ordnance Survey data, as it is effectively a census of the total land area.

In summary, we note the following points about these estimates:

1. The forest area budget method would be expected to be reasonably unbiased, but with poor resolution.
2. The NCMS data fall within the bounds of the forest area budget method, and provide our best, though conservative, estimate of historical deforestation.
3. The estimates from the Countryside Survey data appear excessive, given that i. they fall so far outwith the bounds of the forest area budget; and ii. urban expansion over the 1990s was of the order of 8000 kha y^{-1}.
4. The felling licence data are the most direct source of data, but will almost certainly be an underestimate.
5. The Ordnance Survey mapping data may give an accurate estimate of recent deforestation for non-rural uses which do not require a felling licence data. However, we suspect they may overestimate rural deforestation.

8.1 Plot size

The minimum plot size used in survey schemes will affect calculated deforestation rates. Changes in the minimum plot size used will affect the estimate of total forest area, and therefore, the estimate of change in forest area in equation 1, and the deforestation rate in equation 2. The minimum plot size used in the FC Woodland Census has decreased from 2 ha in 1940 to 0.1 ha in 2000. To investigate this, we used the National Inventory of Woodland & Trees 2000 data to calculate the forest area which would be excluded if larger minimum plot sizes were used (Fig 5). For each minimum value, the total GB forest area was calculated, ignoring areas of forest smaller than this value. Figure 5 shows that around 60000 ha would not be recorded if a minimum plot size of 2 ha were used. Assuming the size distribution of forest areas has remained the same, a correction factor can be calculated to normalise earlier Woodland Census data with larger minimum plot size. This is simply the total forest area calculated with a given minimum plot size, expressed as a fraction of the total calculated with a minimum plot size of 0.1 ha. This changes the 1940 total area estimate by 2.3 %, but all other values by less than 1 %, and does not substantially change the calculated ΔArea or deforestation rate.

The minimum plot size used in survey schemes is could also affect the definition of deforestation eg. if deforestation occurred as mosaic of small patches, one scheme may include this as deforestation, another scheme with a larger minimum plot size may exclude it. In general, the turnover rate of small areas is likely to be higher than large areas. However, the NCMS and the Countryside Survey use similar minimum plot sizes (~0.1 ha).

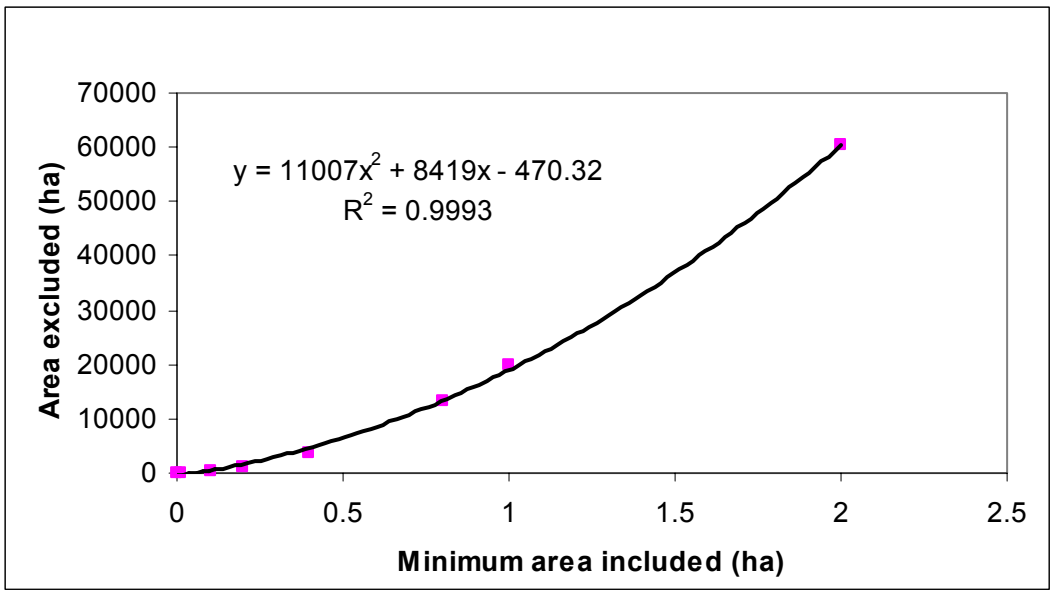

Figure 5 Area excluded from the total GB forest area, calculated using different minimum plot areas with the National Inventory of Woodland & Trees 2000 data.

9 References

Barr, C.J. 1993. Countryside survey 1990: main report (Countryside 1990 series v.2). Department of the Environment, Eastcote, p. 174.

Forestry Commission. Facts & Figures. Published annually as an appendix to the Annual Report.

Forestry_Commission 2000. National Inventory of Woodland and Trees.

Haines-Young, R.H. 2000. Accounting for nature: assessing habitats in the UK countryside. DETR, London, p. 17.

Haines-Young, R.H., C. Watkins, R.G.H. Bunce and C.J. Hallam 1996. Environmental accounts for land cover. (Countryside 1990 series vol.8). Department of the Environment, London.

Mackey, E.C., M.C. Shewry and G.J. Tudor 1999. Land Cover Change: Scotland from the 1940s to the 1980s. HM Stationery Office, Edinburgh. 300 p.

Smith, P. 2001. Forestry Statistics: a compendium of statistics about forestry and wood processing in the UK. Forestry Commission, Edinburgh, p. 44.