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Forest Condition 1997

INFORMATION NOTE

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SUMMARY

Crown density and various other features were assessed on a total of 8760 trees of five species - Sitka spruce, Norway spruce, Scots pine, oak and beech - distributed over 365 plots. Except for a slight improvement in Scots pine, crown condition deteriorated in all species this year. The change was greatest in oak, beech and Sitka spruce, and was all the more notable in the latter since it ended a period of almost continuous improvement since 1988. The condition of Scots pine and Norway spruce was similar to that in 1996, having changed little since 1993.

INTRODUCTION

1. Since 1987 the Forestry Commission has monitored changes in the condition of forest trees by annually re-assessing five species in plots distributed throughout Britain. In 1997 a total of 8760 trees was assessed distributed over the following numbers of plots: 77 Sitka spruce (*Picea sitchensis* (Bong.) Carr.), 64 Norway spruce (*P. abies* (L.) Karst.), 79 Scots pine (*Pinus sylvestris* L.), 83 oak (*Quercus* spp.) and 60 beech (*Fagus sylvatica* L.). There were also two plots in mixed crops. The assessments were carried out between 30 June and 15 September 1997.

2. The feature of greatest interest in the survey is an assessment of crown density, i.e. the degree of transparency of the crown, which is used to provide an index of tree condition. Until 1993 the basis for comparison was an 'ideal' tree carrying the maximum possible amount of foliage. However, in similar surveys conducted in most other European countries comparisons are most commonly made with reference to a tree with full foliage under local conditions (the 'local tree' method). Usually, this method involves selecting, in the general vicinity of the plot, the tree with the greatest amount of foliage, to act as a reference. Selected trees may differ from year to year. In order to harmonize with results obtained in other countries, crown density estimates have been made using the local tree method since 1993. However, in order to maintain the existing time series of crown density figures, all plot trees have also been assessed using the previous idealised standard.

3. Reductions in crown density were estimated in 5% classes by reference either to a standard set of photographs of 'ideal' trees (Innes, 1990) or to 'instant' photographs of individual local reference trees.

4. In order to check the consistency of scoring by the 16 survey teams involved, 88 plots were re-surveyed by one experienced supervisor. The proportion of trees for which the two scores fell within one 5% class ranged from 81% in oak to 88% in Sitka spruce. The corresponding figures for two class limits (10%) were 95% and 99%, for oak and beech respectively. There was no evidence of consistent bias among survey teams (i.e. bias affecting several species) or among species. Differences between the survey teams and the standard observer equalled or exceeded one 5% class interval for only two team/species combinations out of 48 tested. Since the teams operate on a regional basis this lack of bias increases confidence in the geographical interpretation of results.

THE 1997 RESULTS

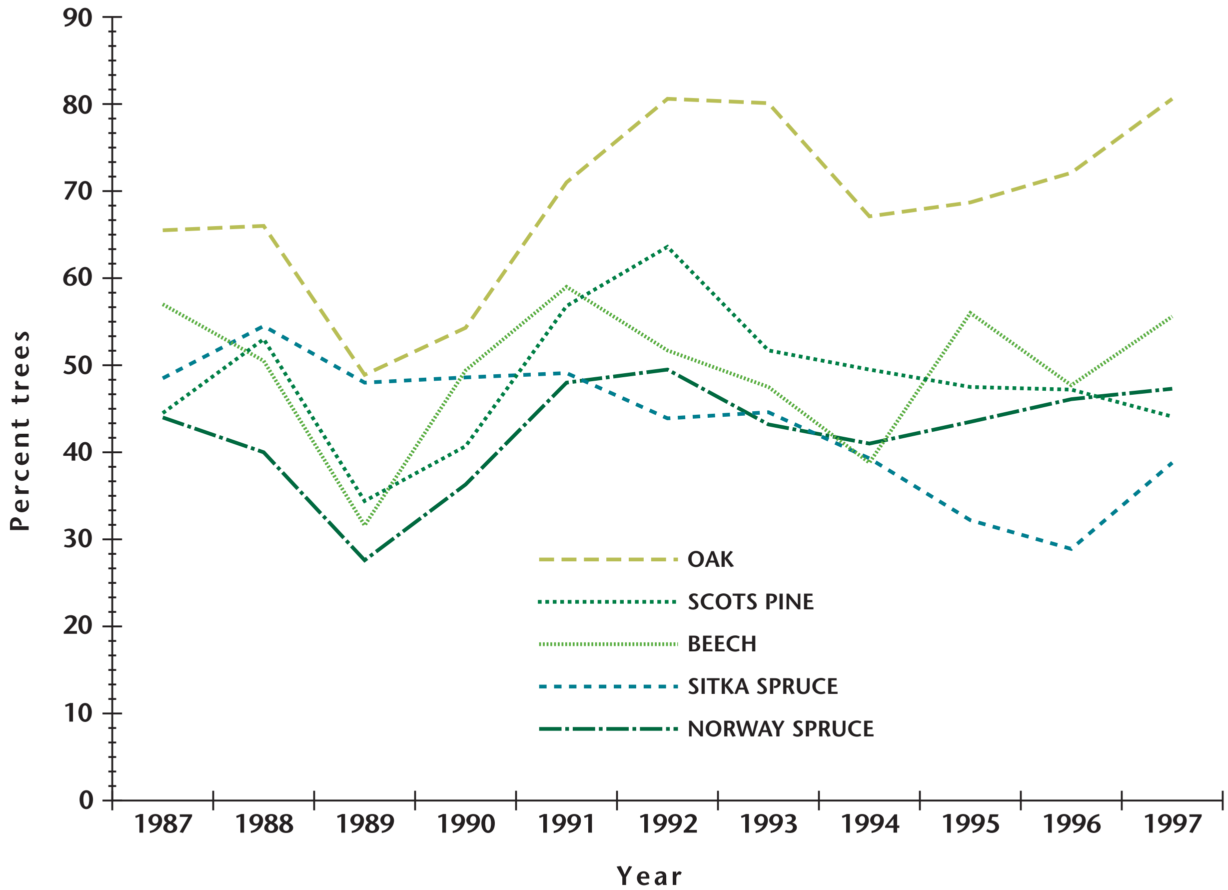
5. The crown density results, using both methods of assessment, are presented in 10% classes in Table 1. The marked effect of using a local reference rather than an ideal tree as the basis for comparison can be clearly seen in all species.

6. Figure 1 shows the changes in crown condition that have taken place since 1987 by recording the proportion of trees in which the reduction in crown density, compared with that of an ideal tree, has exceeded 25%.

Table 1 **Percentages of trees in each crown density class for five species in 1997.**
Each 10% class represents a reduction in crown density compared either to an 'ideal tree' (I), i.e. a tree with the maximum possible amount of foliage, or to a 'local tree' (L), i.e. a tree with full foliage under local conditions.

% reduction in crown density	Sitka spruce		Norway spruce		Scots pine		Oak		Beech	
	I	L	I	L	I	L	I	L	I	L
0 - 10	12.7	39.0	11.4	39.1	5.7	43.0	1.2	29.1	2.7	45.6
11 - 20	31.3	34.8	26.4	32.1	31.5	33.1	9.2	31.4	24.1	35.1
21 - 30	29.2	16.5	29.4	16.3	34.6	15.4	22.5	19.5	36.2	12.2
31 - 40	15.2	6.1	18.7	6.1	18.8	5.3	32.0	11.5	21.0	4.7
41 - 50	7.2	1.4	6.2	2.4	6.1	1.4	19.2	4.5	11.0	1.6
51 - 60	1.7	1.3	3.3	1.2	1.8	1.0	9.2	1.8	2.7	0.2
61 - 70	1.1	0.6	1.5	0.7	0.7	0.2	3.2	1.2	1.4	0.3
71 - 80	1.2	0.1	0.7	0.4	0.3	0.1	2.1	0.6	0.4	0.0
81 - 90	0.2	0.0	0.5	0.1	0.2	0.1	0.8	0.1	0.1	0.1
91 - 100	0.3	0.2	1.8	1.6	0.4	0.4	0.6	0.3	0.3	0.2

Figure 1 Changes in crown density since 1987 for five species surveyed annually. The proportion of trees in which crown density was reduced by more than 25% compared to an ideal tree is shown for each species.



An **upward** gradient in Figure 1 would therefore indicate a **deterioration** in crown condition. Apart from a gradual improvement in Sitka spruce, which continued almost annually from 1988 to 1996, crown density scores have fluctuated over this period revealing little evidence of a long-term trend for any species. However, it is interesting to note that there appear to be short-term effects that are broadly common for four out of the five species. Analysis has shown that whereas most of the annual changes in the condition of Sitka spruce were not significant, larger changes in the other species generally were significant, particularly in the case of beech.

7. Except for a slight improvement in Scots pine, crown condition deteriorated in all species this year. The change was greatest in oak, beech and Sitka spruce, and was all the more marked in the latter species since it brought to an end a period of almost continuous improvement since 1988. The condition of Scots pine and Norway spruce was similar to that in 1996, having changed little since 1993. The deterioration in oak and beech since 1994 has eliminated an earlier short period of improvement and the crown condition of both species was as poor in 1997 as it had been after the droughts of 1989 and 1990.

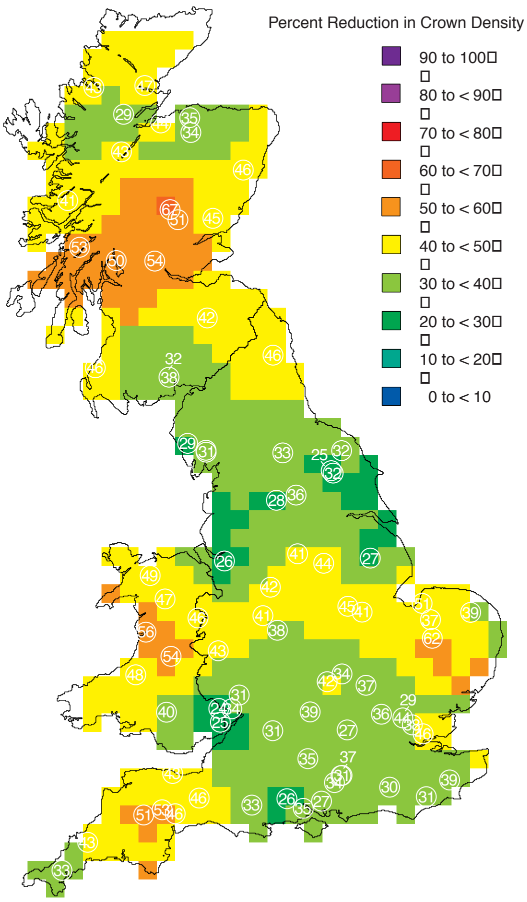
8. Figure 1 suggests that oak is consistently in poorer condition than the other species and that in recent years the difference has been in the order of 20–25%. The size of this difference is to some extent an artefact of the way in which the results in the Figure are presented, since it records only the proportion of trees in which crown density is reduced by more than 25%. For some purposes this is considered to be a more useful statistic than the mean, and it is presented in this form here in the interests of consistency. However a slightly misleading impression might be created if species are compared. This is best done by comparing means. In 1997 the mean percent reductions in crown density were: oak 39%, beech 31%, Norway spruce 29%, Scots pine 28% and Sitka spruce 26%. Oak is clearly in poorer condition than the other species included in the survey but the difference is less dramatic than the data in Figure 1 imply.

9. Figure 2 shows the geographical variation in crown density for the five species assessed. Variation was greatest in oak, which was notably poor in central Scotland, south-west England and in a belt across Wales, the Midlands and East Anglia. This is broadly the same pattern that was observed in 1996 (Redfern *et al.*, 1997). Neither beech nor Scots pine showed marked patterns, though in Scots pine there was a tendency for crown density to be highest south of the Humber–Mersey line. In 1996 this distinction was rather more evident. Both spruces were in slightly poorer condition in the south and east than elsewhere but this impression is created by relatively few plots and both species show considerable local variation.

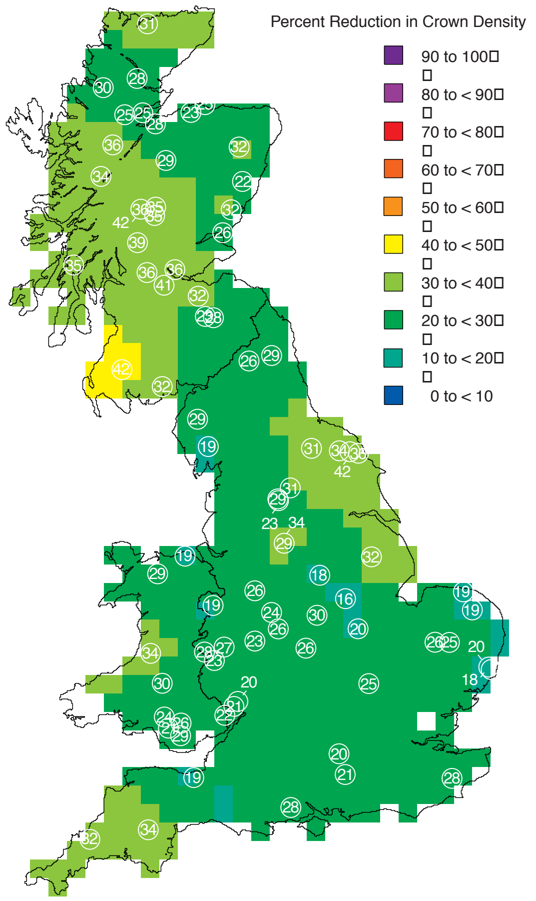
Figure 2

Geographical variation in crown density for five species in 1997. The locations of plots included in the survey are indicated by white circles, and the figures within these are mean percent reductions in crown density. Some plots are too close to be distinguished individually. The value assigned to each 20 km square was calculated from weighted averages (weight $\propto 1/d^2$, where d = distance) for all plots within 70 km of the 20 km square centre.

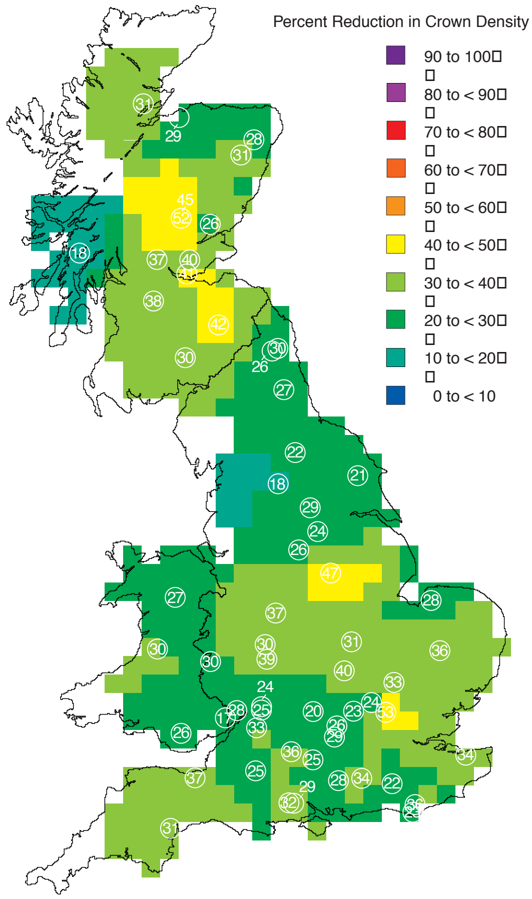
Oak 1997



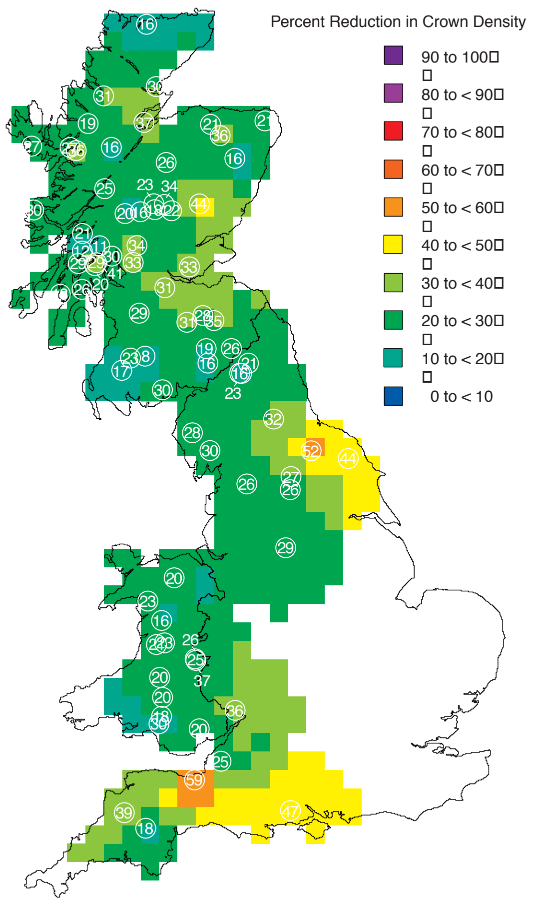
Scots pine



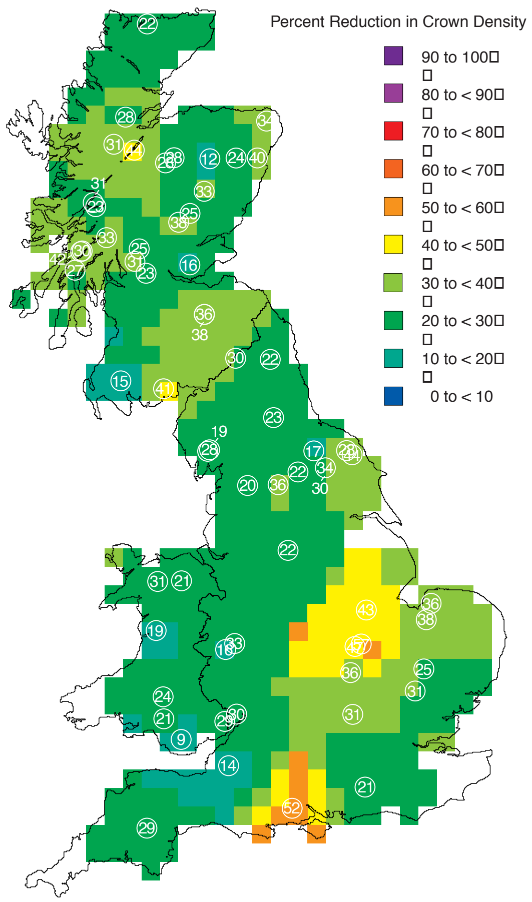
Beech 1997



Sitka spruce 1997



Norway spruce 1997



FACTORS AFFECTING CROWN CONDITION IN 1997

10. Rainfall throughout the country was generally closer to average than in 1995 and 1996, especially in the summer, but symptoms suggesting the continuing effect of drought on non-woodland trees were widely reported from England (Gregory *et al*., 1997). No clear signs of drought damage were evident in the woodland trees included in the survey reported here; for a variety of reasons woodland trees tend to be less vulnerable to drought than individual trees in hedgerows and on roadsides. Nevertheless, the continuing poor condition of beech in particular may be a long-term effect of drought. Heavy mast production was recorded in some areas and contributed to the thinness of beech crowns. A severe frost in May caused damage to several species but its effects were particularly severe on oak in the south and east of England.

11. The most important damage to oak was caused by the May frost already referred to and by defoliating insects such as the winter moths *Operophtera brumata* and *Erannis defoliaria*, and by the oak leaf roller moth (*Tortrix viridana*). Both agents caused virtually 100% defoliation in some plots in May/June. Oaks usually recover quite rapidly from early defoliation so that when the survey was carried out the full effects would no longer have been apparent. Nevertheless these two factors are likely to have significantly affected crown condition this year. Frost effects were noted in 11 plots and insect defoliation in 21 plots. In all of the latter the reduction in crown density exceeded 40%. It is interesting to note that three plots which had suffered repeated and severe defoliation since 1992 had little evidence of attack this year. Their condition improved, but only slightly, suggesting that recovery may be delayed. Other causes of injury were minor or localised and included oak mildew (*Microsphaera alphitoides*), storm damage in Scotland and leaf browning and gall formation by the gall wasps *Neuroterus albipes* and *N. numismalis*. In East Anglia a condition of oak characterised by death and dieback (Gibbs and Greig,1997) contributed to the relatively high levels of defoliation there.

12. The decline in beech compared to 1996 took place generally throughout the country and was associated with a variety of factors which included the effects of past drought, frost, and attack by the leaf mining insect *Rhynchaenus fagi*. Yellowing of foliage, and small leaves in the upper crown were unusually common features this year and may be symptoms of some form of abiotic stress.

13. Compared to the other three species the condition of Norway spruce and Scots pine has changed little since 1993. During that time Norway spruce has deteriorated slightly while Scots pine has steadily improved. In 1997 Scots pine was affected by the pine shoot beetle *Tomicus piniperda* and by breakage caused by wind and snow. Norway spruce was defoliated by the green spruce aphid (*Elatobium abietinum*) but it is less susceptible than Sitka spruce and damage was slight. Crown distortion caused by the bud blight fungus *Cucurbitaria piceae* (*Gemmamyces piceae*) was observed in plots of older trees in north England and south-west Scotland but it had little effect on crown density. As in previous years plots with the lowest crown density were affected by the climatic/physiological disorder known as 'top dying' in which pole-stage trees on unsuitable sites decline and die over a period of several years.

14. The sharp deterioration in the condition of Sitka spruce was due almost entirely to widespread and severe defoliation by *Elatobium abietinum*. Populations were high throughout the country and attacks were reported from 54 plots. Damage was severe in 18 plots and minor in the remainder. Casual observation suggested that damage was greater in the east than in the west, though this may have been due to an interaction with earlier drought rather than to *Elatobium* alone. The effects of spring frost were recorded in 16 plots in Scotland and north England but it was only a minor cause of injury.

CONCLUSIONS

15. 1997 was wetter than the previous two years and was generally a good year for tree growth. In spite of this the condition of oak, beech and Sitka spruce deteriorated significantly, largely as the result of defoliation by frost and insects in the case of oak and Sitka spruce. Beech was affected by a number of factors, including heavy masting which may have been induced by high temperatures and low rainfall in 1996. The sharp deterioration in Sitka spruce was due almost entirely to widespread and severe defoliation by *Elatobium*. This ends the general trend of improvement which has continued since the last major

outbreak in 1988–90 (Innes and Boswell, 1991). The condition of Norway spruce has deteriorated slightly since 1993 while that of Scots pine has steadily improved during the same period, but the overall change in the two species has been modest.

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REFERENCES

GIBBS J.N. and GREIG, B. J. W. (1997).
Biotic and abiotic factors affecting the dying back of pedunculate oak *Quercus robur* L.
Forestry 70 : 399–406.

GREGORY, S. C., MACASKILL, G. A., ROSE, D. R., GIBBS, J. N. and TILBURY, C. A. (1997).
The health of non-woodland trees in England in 1997.
Arboriculture Research and Information Note 140/97/PATH.
Arboricultural Advisory and Information Service, Farnham, Surrey.

INNES, J. L. (1990).
Assessment of tree condition.
Forestry Commission Field Book 12.
HMSO, London.

INNES, J. L. and BOSWELL, R. C. (1991).
Forest monitoring programme - 1991 results.
Research Information Note 209.
Forestry Commission, Edinburgh.

REDFERN, D. B., BOSWELL, R. and PROUDFOOT, J. (1997).
Forest condition 1996.
Research Information Note 291.
Forestry Commission, Edinburgh.

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