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Forest Condition 1999

INFORMATION NOTE

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SUMMARY

Crown density and various other features were assessed on a total of 8471 trees of five species - Sitka spruce, Norway spruce, Scots pine, oak and beech - distributed over 355 plots throughout Britain. Growing conditions during 1999 were good and the condition of all five species changed little compared with 1998. A slight improvement in the condition of Sitka spruce probably represents a gradual recovery from a severe attack by the green spruce aphid, *Elatobium abietinum*, in 1997. Oak was less affected by winter moth than in previous years but it was still in notably poorer condition in central Scotland and north-east England, south-west England, Wales and East Anglia than elsewhere.

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 1999 a total of 8471 trees was assessed distributed over the following numbers of plots: 68 Sitka spruce (*Picea sitchensis* (Bong.) Carr.), 59 Norway spruce (*P. abies* (L.) Karst.), 80 Scots pine (*Pinus sylvestris* L.), 85 oak (*Quercus* spp.) and 60 beech (*Fagus sylvatica* L.). There were also three plots in mixed crops. The assessments were carried out between 2 July and 20 September 1999.

2. Plots consist of 24 trees, located in four sub-plots of six trees. Trees are scored for various features, such as the incidence of flowering and seed production, or the incidence of damage by insects or fungi, but the feature of greatest interest is an assessment of crown density. This is an estimate of 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. This tree is generally retained as the reference from year to year but another tree may be selected in the event that the original local tree deteriorates. In order to harmonise 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 are 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. Data are collected on hand-held computers and are checked for consistency and for departures from expected values both in the field and before analysis.

4. In order to check the consistency of scoring for crown density by the 16 survey teams involved, 88 plots were re-assessed by one experienced supervisor. The proportion of trees for which the two scores fell within one 5% class ranged from 85% in beech to 89% in Norway spruce. The corresponding figures for two class limits (10%) were 94% for oak and 97%, for Scots pine. Since the teams operate on a regional basis any bias would be a cause for concern but there was evidence neither of consistent bias (i.e. bias affecting several species) nor of a bias in scoring individual species. Differences between the survey teams and the standard observer exceeded one 5% class interval for three of the 47 team/species combinations tested. This was greater than last year but other differences were generally smaller.

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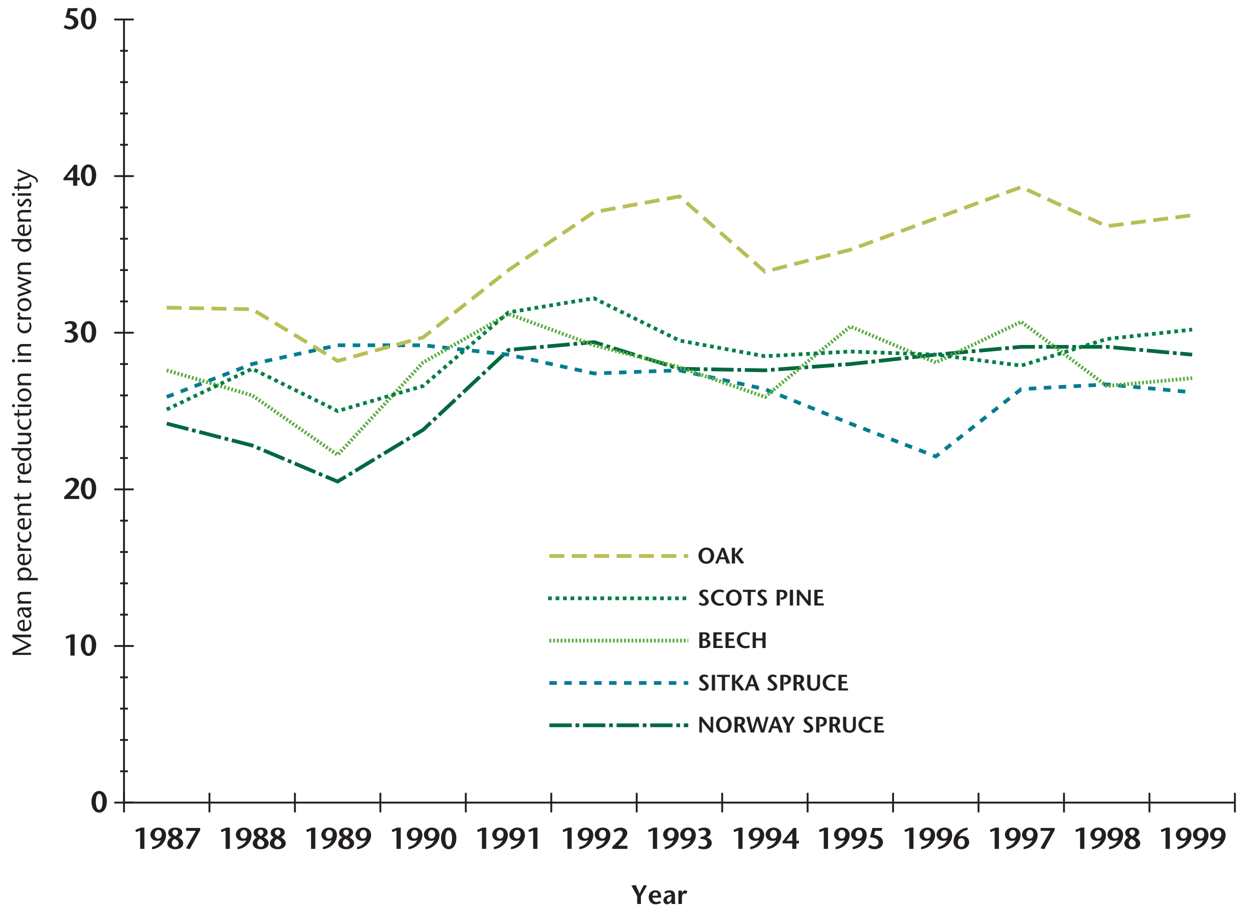
Table 1 **Percentages of trees in each crown density class for five species in 1999.**
Each 10% class represents a reduction in crown density compared either with an 'ideal tree' (I), i.e. a tree with the maximum possible amount of foliage, or with a 'local tree' (L), i.e. a tree with full foliage under 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	11.6	38.0	9.0	35.0	4.9	34.6	1.3	22.6	5.8	47.1
11–20	33.5	34.2	27.8	32.5	22.6	35.7	10.9	31.5	33.7	34.5
21–30	28.5	17.2	32.8	18.8	37.2	18.6	24.8	25.2	34.4	12.7
31–40	16.0	6.6	18.1	7.9	23.7	7.3	33.5	13.0	18.3	3.7
41–50	5.7	2.2	6.7	2.3	7.2	2.1	18.0	4.1	4.9	1.0
51–60	2.7	1.0	2.3	1.3	2.4	0.6	6.8	1.6	1.7	0.3
61–70	0.9	0.4	1.3	0.9	0.9	0.3	2.1	1.0	0.4	0.3
71–80	0.6	0.1	0.5	0.1	0.3	0.2	1.3	0.4	0.3	0.1
81–90	0.1	0.0	0.4	0.1	0.2	0.1	0.6	0.2	0.1	0.0
91–100	0.4	0.3	1.1	1.1	0.6	0.5	0.7	0.4	0.4	0.3

Figure 1 Changes in crown density since 1987 for five species surveyed annually. The reduction in crown density compared with that of an 'ideal' tree is shown for each species.



THE 1999 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 tree rather than an ideal tree as the basis for comparison can be seen for all species. Much of the difference can be accounted for by variations in growth habit between the reference photographs of ideal trees (Innes, 1990) and the trees in and around the plots to be assessed, from among which a local reference tree is chosen. For example, young trees of all species, but particularly Scots pine, tend to have a more open appearance (i.e. a lower crown density) than the older trees illustrated in Innes (1990), and some older oaks and spruces also have a naturally open structure. For trees like this, the apparent reduction in crown density would therefore be much greater when judged against an ideal tree than when compared with local trees of the same age and form.

6. Figure 1 shows the changes in crown condition that have taken place since 1987. An **upward** gradient in this figure indicates a **deterioration** in crown condition. In contrast to the method of presentation used before 1998, the figure records the mean percent reduction in crown density for each species compared with an ideal tree. Changes in crown density compared with last year were minor for all species. Generally only the larger changes in the time series are statistically significant. Thus, despite the trend for gradual improvement in Sitka spruce that continued almost uninterrupted from 1989 to 1996, the annual changes were not significant. This contrasts with the significant and marked annual changes in beech. Apart from the period of improvement in Sitka spruce, crown density scores have generally fluctuated, revealing little evidence of long-term trends, although oak was in better condition before 1991 than it has been in more recent years. Initial analysis of the trends in crown density values suggests that there may have been a significant deterioration in the condition of oak, and also Norway spruce, since 1987. However the analysis required a number of assumptions to be made and the data require more detailed study before this trend can be confirmed. It is interesting to note that oak and beech show short-term trends that are broadly similar.

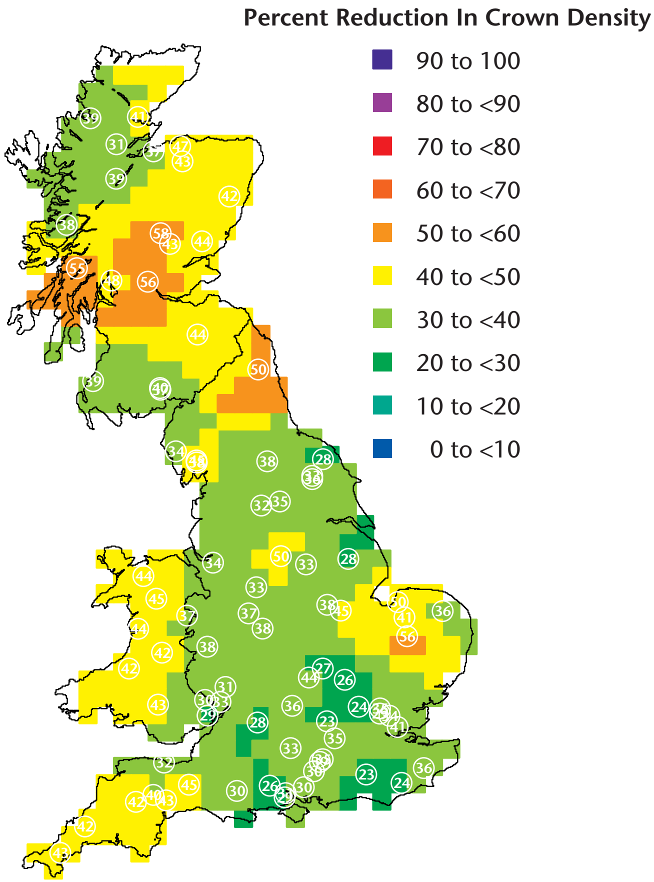
7. Since 1991 the condition of Scots pine and Norway spruce has changed less than that of any other species and there was no significant change in either species in 1999. After a sharp decline in 1997 Sitka spruce was unchanged in 1998 but in 1999 it apparently resumed the trend of improvement established before 1997. Both oak and beech experienced similar declines in 1997 and improved in 1998 but as with all the other species there was virtually no change this year.

8. Figure 2 shows the geographical variation in crown density for the five species assessed. Variation was greatest in oak, which has shown substantially the same pattern since 1996 when data were first presented in this way (Redfern *et al*., 1997; 1998; 1999).

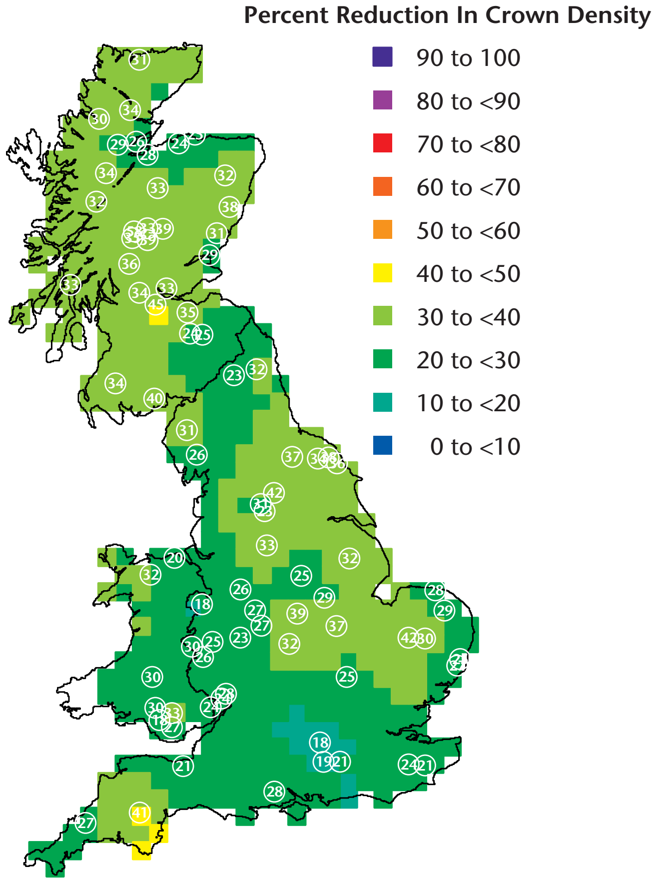
Figure 2

Geographical variation in crown density for five species in 1999. White circles show the locations of plots, and figures within the circles 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 ∝ $1/d^2$, where d = distance) for all plots within 70 km of the 20 km square centre.

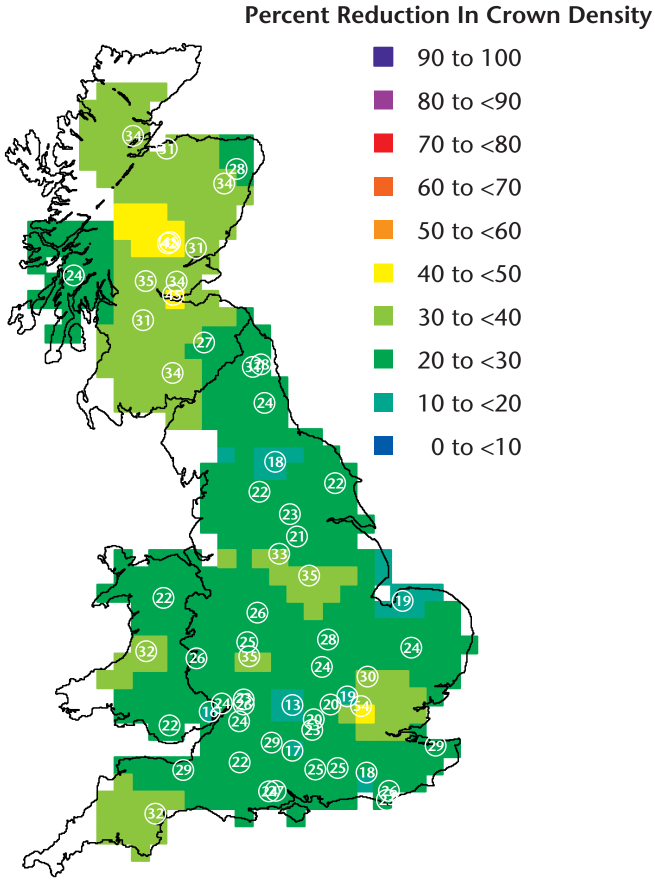
Oak 1999



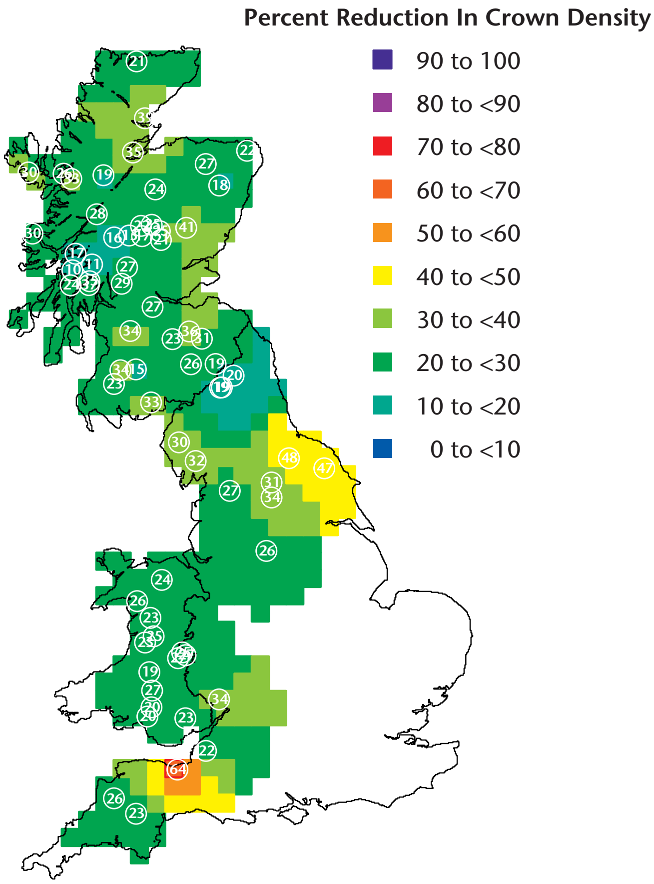
Scots pine 1999



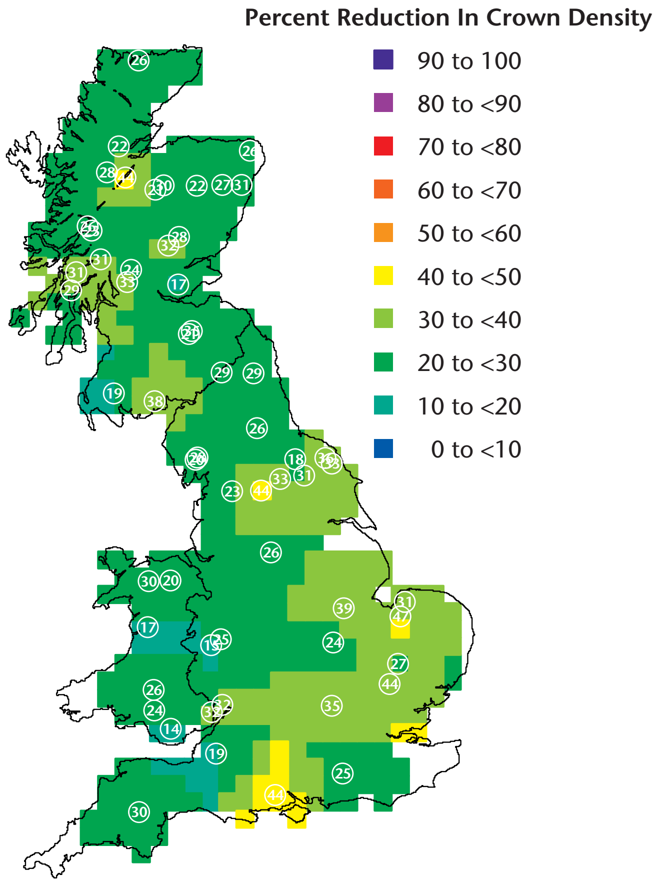
Beech 1999



Sitka spruce 1999



Norway spruce 1999



Oak was poorest in central Scotland and north-east England, south-west England, Wales and East Anglia, and best in southern England. An apparent slight improvement in Wales was due to a marked change in only one plot. Scots pine also showed a pattern that was similar to those in previous years, with crown density tending to be highest south of the Humber–Mersey line. Beech showed no clear pattern in 1998 but this year it was slightly poorer in Scotland than elsewhere. 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.

FACTORS AFFECTING CROWN CONDITION IN 1999

9. The 1999 growing season was warmer than the long-term average. July was notably dry in England and Wales, and August was dry in Scotland, but otherwise rainfall was well distributed through the year and close to average. No drought effects were reported in forest trees. Mid-winter gales caused breakage to conifers in south-west Scotland, and newly flushed broadleaves were damaged throughout Scotland by gales in May. There were no damaging frosts.

10. Defoliating and mining insects can have a major impact on crown condition in oak, and the slight improvement over the last two years compared with 1997 largely reflects lower insect damage levels. This was due principally to a decline in activity by winter moths such as *Operophtera brumata* and *Erannis defoliaria*, which were severe on only three plots this year. Table 2 shows the history of defoliation by winter moths in one plot in central Scotland. Damage in this plot was only minor this year but the trees showed only a small improvement compared with 1998, suggesting that recovery is likely to be slow. In beech, heavy mast formation has been the main cause of poor crown condition in recent years (Redfern *et al*., 1998), and the relative improvement in the last two years was probably associated with poor masting. The incidence of damage caused by the leaf-mining insect, *Rhynchænus fagi*, was somewhat greater this year than in 1998. The increase was relatively small overall but it masked large regional variations. Damage was much greater in Scotland than elsewhere (Figure 3). This may have contributed to the generally poorer crown condition there (Figure 2); even though the principal effect of mining is to cause partial discoloration, affected leaves also tend to shrivel.

The long-term effects of drought and exposure affected a few beech plots. Minor yellowing of leaves, sometimes in the upper crown, was reported from almost one third of plots (26). This has been noted on other occasions in beech but the cause is unknown (Redfern *et al*., 1995).

Table 2

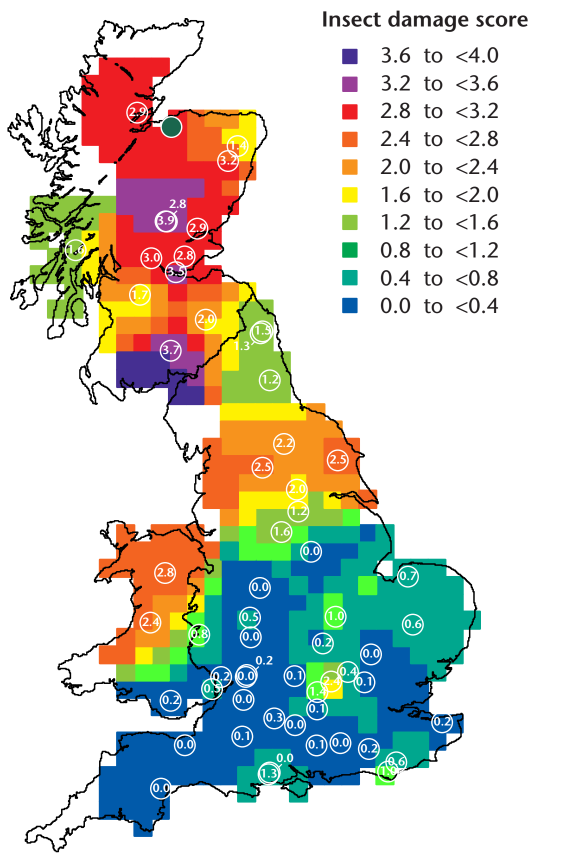
Relationship between crown density and attack by winter moths for a single oak plot in central Scotland.

Year	Mean % reduction in crown density	No. of trees (out of 24) with crown density reduced by 50% or more	Mean insect damage score (scale 0–4)*
1992	45	12	2.8
1993	50	14	2.9
1994	49	13	2.9
1995	66	21	4.0
1996	65	23	3.9
1997	67	21	3.7
1998	60	20	3.1
1999	58	15	1.4

*see caption for Figure 3

Figure 3

Damage to beech caused by the leaf miner *Rhynchaenus fagi*. White circles show the locations of plots, and figures within the circles are mean damage scores. Some plots are too close to be distinguished individually. The damage scores were: 0 = none; 1 = rare; 2 = infrequent; 3 = common; 4 = abundant.



11. The condition of Sitka spruce improved slightly compared with last year. There were fewer reports of damage by *Elatobium*, and lower scores for insect damage (which in effect is a score of *Elatobium* damage) suggest that Sitka spruce is now recovering from the severe outbreak of 1997. Exposure injury and abrasion by wind were reported from 10 plots but Sitka spruce was less severely damaged by gales than Scots pine or Norway spruce, which suffered local effects in south-west Scotland and north England. As in previous years, minor amounts of damage were caused by the pine shoot beetle, *Tomicus piniperda*, and by the fungi *Lophodermium seditiosum* and *Peridermium pini*. Shoot death caused by the bud blight fungus *Cucurbitaria piceae* (*Gemmamyces piceae*) was noted in 19 Norway spruce plots in north England and Scotland. It was recorded for the first time in this survey in south-west England. The disease mainly causes relatively minor crown distortion, but in two plots infection was sufficiently severe to reduce crown density.

CONCLUSIONS

12. Apart from a relatively short dry period in late summer, rainfall was well distributed throughout the growing season and growth was generally good. Winter gales caused localised damage to conifers but no other forms of climatic injury were important this year. The condition of all species was similar to that in 1998. Changes were slight and within the range of fluctuations recorded since 1992. A slight improvement in Sitka spruce probably represents a gradual recovery from a severe outbreak of *Elatobium* in 1997. Oak was less affected by winter moth defoliation than in previous years, but was still in poor condition in central Scotland and north-east England, south-west England, Wales and East Anglia. Recovery is likely to be slow in the most severely affected plots. Beech in Scotland was severely affected by *Rhynchaenus fagi*. This caused discoloration of foliage but the effect on crown density was only minor. *Cucurbitaria piceae* may be more common on older Norway spruce than has previously been realised.

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