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Forest Condition 2000

INFORMATION NOTE

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SUMMARY

Crown density and various other features were assessed on a total of 8 376 trees of five species – Sitka spruce, Norway spruce, Scots pine, oak and beech – distributed over 349 plots throughout Britain. Despite good growing conditions during 2000, the condition of Norway spruce changed little compared to 1999. Scots pine, however, which has displayed little change in condition since 1994 showed a minor improvement. A slight increase in the crown density of Sitka spruce probably represents a continued recovery from the severe attack by green spruce aphid (*Elatobium abietinum*) which this species suffered in 1997. With an improvement in 2000, oak was in better condition than at any time since 1995, although crown density is still notably poorer than during the late 1980s. A marked deterioration in beech this year was associated with heavy mast production.

INTRODUCTION

1. Since 1987 the Forestry Commission has monitored annual changes in the condition of Britain's forest trees by assessing the status of five forest species via a network of monitoring plots distributed throughout the country. In 2000 a total of 8 376 trees was assessed distributed over the following numbers of plots: 66 Sitka spruce (*Picea sitchensis* (Bong.) Carr.), 55 Norway spruce (*P. abies* (L.) Karst.), 81 Scots pine (*Pinus sylvestris* L.), 85 oak (*Quercus spp.*) and 59 beech (*Fagus sylvatica* L.). There were also three plots in mixed stands of Sitka spruce and Scots pine. The assessments were carried out between 19 June and 14 September 2000.

2. Plots consist of 24 trees, located in four sub-plots of 6 trees. Trees are scored for various features, such as the incidence of flowering and fruiting, 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 the tree with the greatest amount of foliage in the general vicinity of a survey plot to serve as a reference against which the plot trees are assessed. Although the same local tree is generally retained from year to year, it may be replaced by another tree in the event that its condition 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.

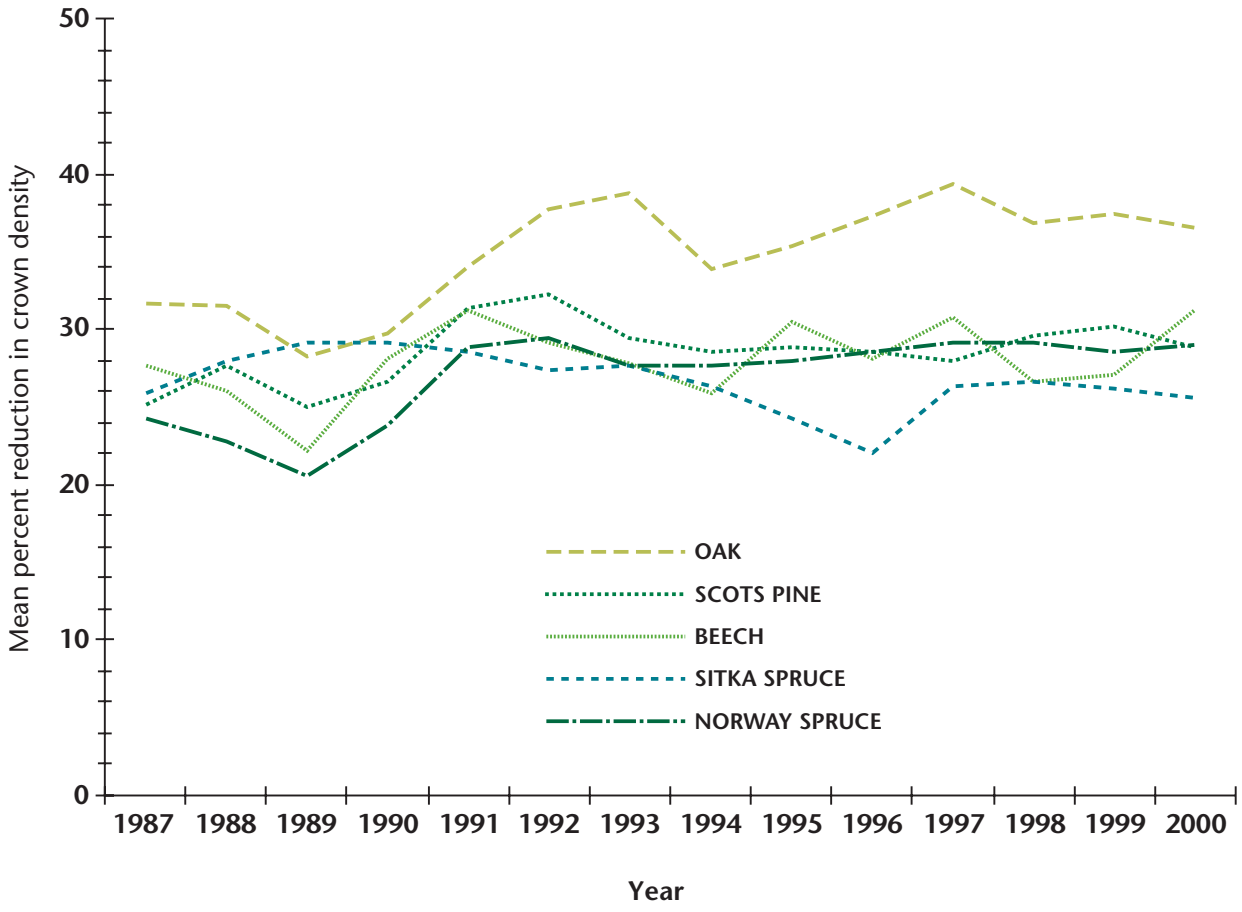
3. Reductions in crown density are estimated in 5% classes by reference either to a standard set of photographs of 'ideal' trees (Innes, 1990) or to 'instant' photographs of individual local reference trees. Data are collected on hand-held computers and are checked for consistency and for departures from expected values both in the field and before analysis.

4. In order to check the consistency of scoring for crown density by the 18 survey teams involved, 99 plots were re-assessed by one experienced supervisor. The proportion of trees for which the scores of the survey team and standard assessor fell within one 5% class ranged from 78% in Norway spruce to 87% in oak. The corresponding figures for two class limits (10%) were 92% for Norway spruce and 97% for Sitka spruce. 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 only one of the 56 team/species combinations tested.

Table 1 **Percentages of trees in each crown density class for five species in 2000.** 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	12.6	34.6	9.2	30.8	7.1	36.3	1.5	27.2	2.5	34.0
11–20	30.4	34.5	26.8	34.9	26.1	35.5	12.5	32.4	21.4	37.8
21–30	31.6	19.2	30.6	19.5	34.4	18.0	26.8	24.1	34.2	19.4
31–40	17.1	8.2	19.7	8.1	21.8	6.6	32.8	9.4	28.8	6.2
41–50	5.6	1.9	7.7	3.5	7.1	1.8	15.8	3.5	9.2	1.6
51–60	1.5	0.8	2.9	1.1	1.7	0.8	6.2	1.3	2.5	0.3
61–70	0.5	0.4	0.9	0.8	0.7	0.3	1.6	0.9	0.4	0.1
71–80	0.3	0.2	1.0	0.2	0.4	0.1	1.4	0.4	0.4	0.1
81–90	0.2	0.1	0.1	0.0	0.2	0.1	0.5	0.3	0.2	0.1
91–100	0.2	0.1	1.1	1.1	0.5	0.5	0.9	0.5	0.4	0.4

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



THE 2000 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 to 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 to an ideal tree. Changes in crown density compared to last year were minor for all species except beech, the condition of which deteriorated significantly. Analysis of the time series for each species shows that, in general, only relatively large changes in crown density (more than 3% to 4%) between years are statistically significant. Short-term changes of such magnitude, both positive and negative, have characterised beech over the fourteen year survey period. However, there is no evidence of a long-term deterioration or improvement of crown condition in this species. Similarly, no long-term trends can be detected in the crown densities of either Scots pine or Sitka spruce, although the latter is the only species currently in better condition than at the commencement of the survey in 1987. Analysis of the 1987–2000 data indicates that a statistically significant deterioration in crown condition has occurred for both oak and Norway spruce over the duration of the survey. However, the time series is of relatively short duration and the indicated rates of change are small, with an apparent reduction in crown density of 0.57% per annum in oak and 0.47% per annum in Norway spruce. The magnitudes of past increases in crown density in these species suggest that a single year of improvement could nullify the current trends.

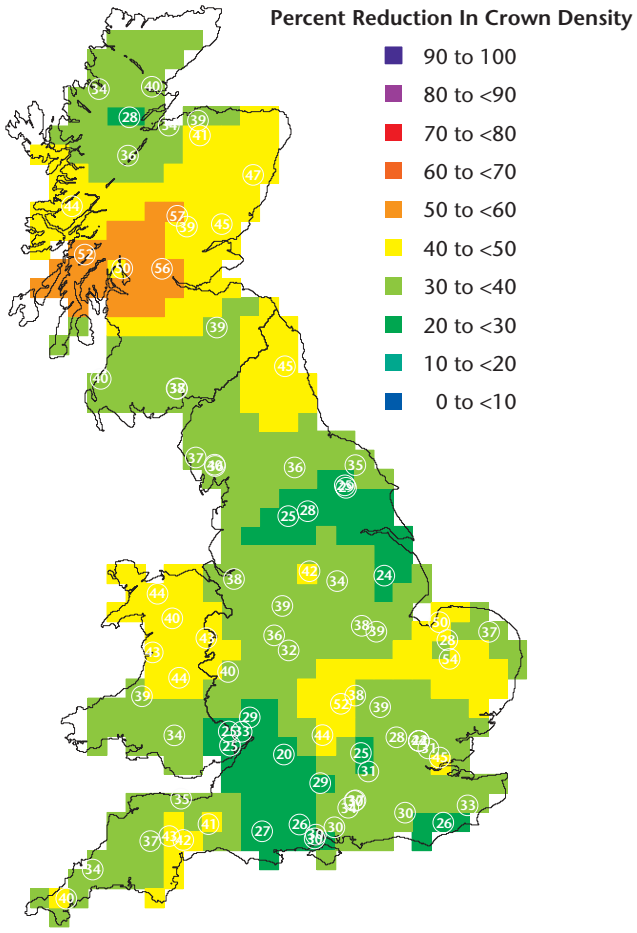
7. Since 1991 the condition scores of Scots pine and Norway spruce have changed less than those of any of the other species. Although Norway spruce displayed no significant change in 2000, the condition of Scots pine showed a slight improvement. Following a sharp decline in 1997, the condition of Sitka spruce began to improve in 1999 and this recovery continued in 2000. Oak also improved this year, reversing the slight deterioration recorded in 1999, and was in better condition than at any time since 1995. However, it is still markedly poorer than during the late 1980s. The decline in beech recorded in 2000 completely reversed the improvement recorded in 1998 and crown density was reduced to the lowest level recorded since 1991.

8. Figure 2 shows the geographical variation in crown density for the five species assessed. Variation was

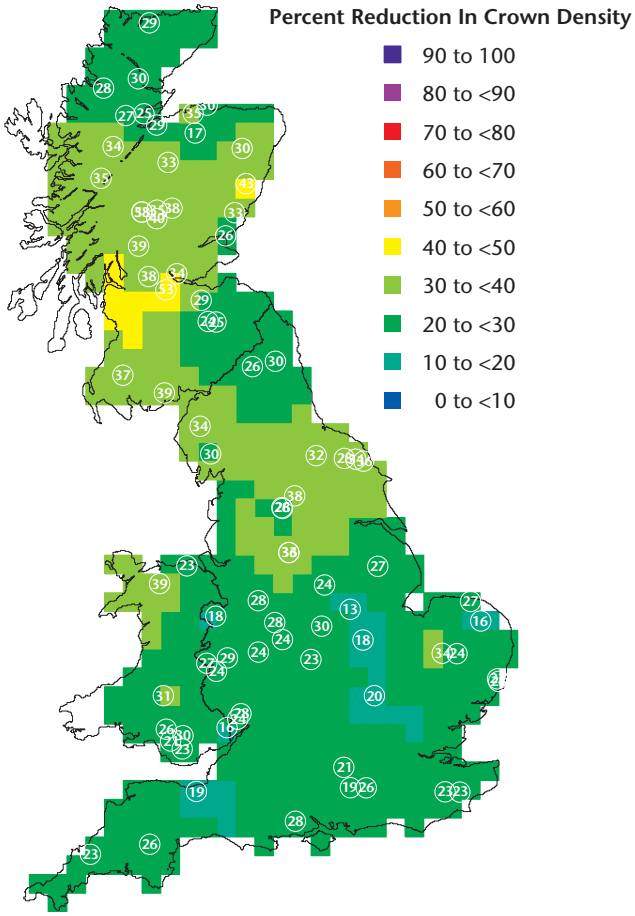
Figure 2

Geographical variation in crown density for five species in 2000. 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 $\propto 1/d^2$, where d = distance) for all plots within 70 km of the 20 km square centre.

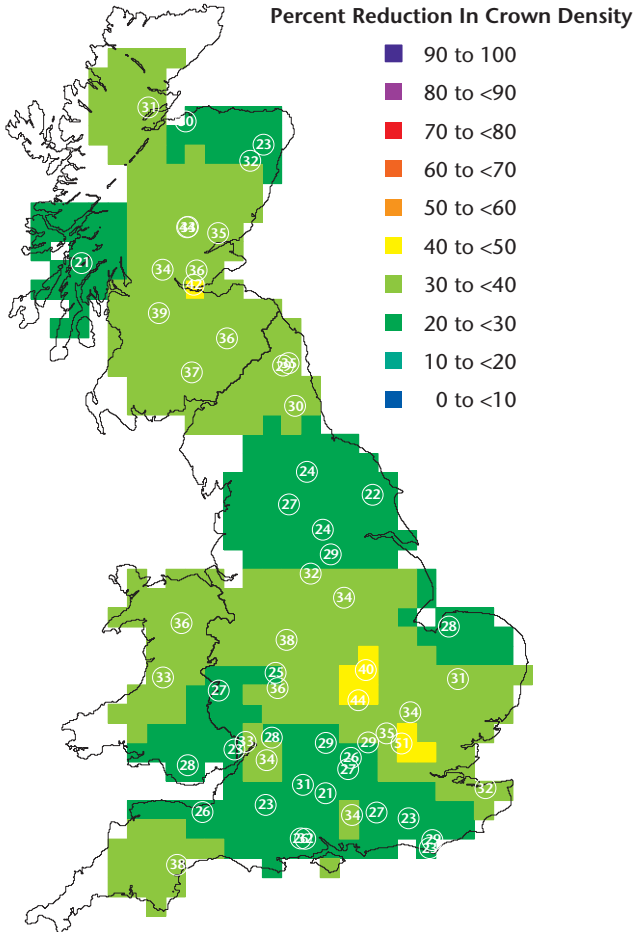
Oak 2000



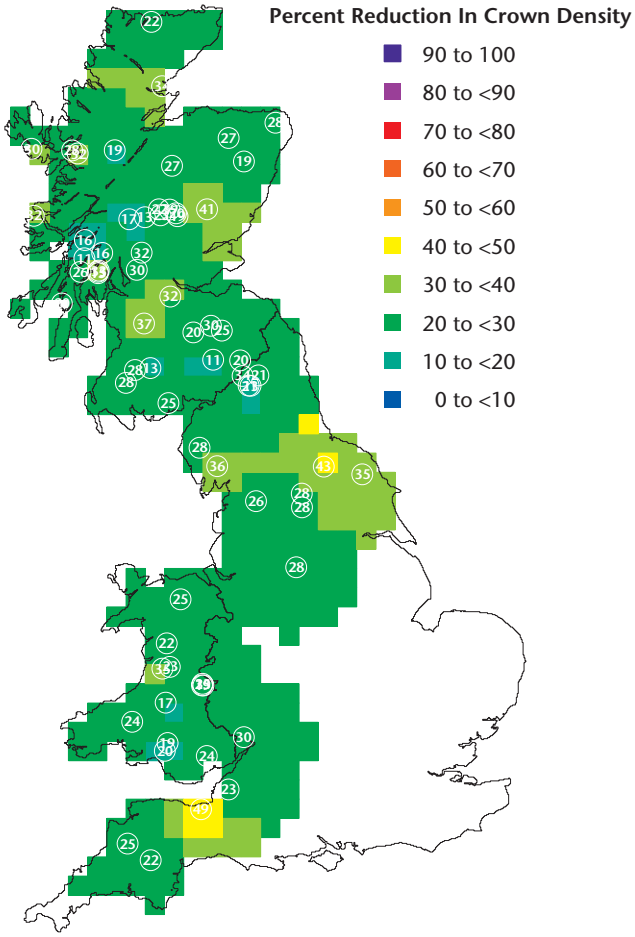
Scots pine 2000



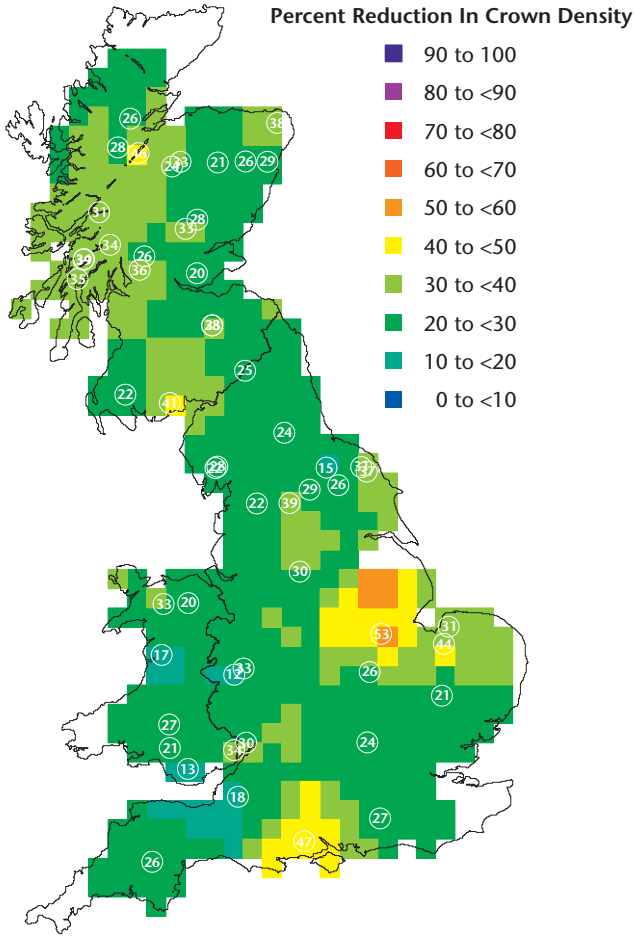
Beech 2000



Sitka spruce 2000



Norway spruce 2000



greatest in oak, which has shown substantially the same pattern since 1997 when data were first presented in this way (Redfern *et al*., 1998; 1999; 2000). Oak was again poorest in central Scotland and north-east England, south-west England, Wales and East Anglia, and best in southern England. Scots pine also displayed 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. Both spruces were poorest 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 2000

9. Over much of the country April and the beginning of May were extremely wet but the consistent cloud cover over this period contributed to the absence of damaging spring frosts. Unprecedented high winds in mid-June resulted in shoot loss and browning of current year needles in two Norway spruce and four Sitka spruce plots in the north of the UK. In spite of extremely dry weather over much of Scotland in July, no drought damage to forest trees was reported. The remainder of the growing season was generally warm and wet.

10. The deterioration in beech this year was of similar magnitude to former declines in 1990 and 1995 (Figure 1). As in these previous cases (Redfern *et al*., 1996), the reduction in crown density in 2000 was associated with heavy mast production (Table 2). Although the deterioration in the condition of beech and the increased fruiting noted in 1990 were considered as separate manifestations of stress caused by the drought of 1989 (Innes & Boswell, 1991), neither the 1995 nor 2000 growing season were preceded by drought years. However, since female flowers and subsequently fruits occupy positions which might otherwise give rise to vegetative shoots bearing foliage, heavy fruiting alone may bring about a reduction in crown density.

11. Although the condition of oak is better than for several years, it is still poorer than any of the other species surveyed. As in previous years, this appears to be due largely to insect damage which was recorded in 74 of the 85 plots assessed. Plots with low crown density were generally those in which insect activity was scored as heavy or severe, although oak dieback (Gibbs, 1999) appeared to be the primary cause of poor condition in four plots in England.

12. The condition of Sitka spruce improved slightly compared to last year. There were few reports of major damage by green spruce aphid and scores for insect damage remained at the low levels recorded in 1999, suggesting that Sitka spruce is continuing a gradual recovery from the severe *Elatobium* outbreak of 1997. Exposure injury and abrasion by wind were reported from 13 Sitka spruce and 23 Norway spruce plots. The condition of Norway spruce was virtually unchanged in 2000, with only minor damage from insects and fungi being recorded.

13. The improvement in Scots pine this year reflected a marked increase in the number of trees in the lowest defoliation classes (0–20% reduction in crown density) despite levels of damage from the pine shoot beetle (*Tomicus piniperda*) and by the fungi *Lophodermium seditiosum* and *Peridermium pini* which were similar to those recorded in 1999. However, counts of needle retention demonstrated a marked increase in the number of trees retaining needles for 2 or more years in 2000.

Table 2

Percentages of beech trees in four masting classes between 1989 and 2000. Years in which heavy masting occurred are indicated by darker shading.

Year	Percentage of trees with mast score			
	0	1	2	3
1989	58.7	29.1	9.1	3.1
1990	5.5	11.4	33.2	49.9
1991	94.2	4.9	0.9	0.0
1992	51.6	25.8	13.5	9.1
1993	42.5	29.5	20.5	7.5
1994	61.0	27.5	9.4	2.1
1995	6.6	16.1	28.5	48.8
1996	54.6	23.9	15.1	6.4
1997	25.1	31.5	23.2	20.2
1998	55.0	20.6	17.2	7.2
1999	56.7	24.3	12.8	6.2
2000	7.2	16.1	34.2	42.5

(Mast scores indicate intensity of mast production as follows: 0 = none; 1 = scarce; 2 = common; 3 = abundant)

CONCLUSIONS

14. Apart from a relatively short dry period over the north of the country in July, rainfall was well distributed throughout the growing season and tree growth was generally good. Unseasonal high winds in June caused localised damage to Sitka spruce and Norway spruce in Scotland but no other forms of climatic injury were important this year. Changes in crown density were minor in all species except beech, the condition of which deteriorated significantly. However, this change was associated with heavy mast production, which has been recorded during previous episodes of sharp reduction in beech crown density, and is not necessarily an indication of ill health. A slight improvement in condition this year suggests that Sitka spruce is continuing a gradual recovery from the severe outbreak of Elatobium which affected it in 1997. Oak, although better in 2000 than for several years, is still in poorer condition than the other surveyed species. Crown density in Norway spruce has displayed only minor fluctuations since 1991 and remained virtually unchanged in 2000. Scots pine improved slightly, largely due to an increase in the number of needle years retained by trees.

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