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Forest Condition 2004

INFORMATION NOTE

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SUMMARY

Crown density and other features indicative of tree condition were assessed on a total of 8256 trees of five species – Sitka spruce, Norway spruce, Scots pine, oak and beech – distributed over 344 plots throughout Britain. Growing conditions during 2004 were generally good and the condition of all of the surveyed species except beech showed some improvement. A distinct increase in the crown density of Sitka spruce this year appears to mark the start of a recovery from the green spruce aphid attacks which the species suffered in 2002 and 2003. The condition of Scots pine also improved slightly as a result of increased needle retention. A marked deterioration in the condition of beech was associated with abundant mast production and is not necessarily an indication of poor health.

INTRODUCTION

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 permanent monitoring plots distributed throughout the country. In 2004 a total of 8256 trees was assessed distributed over the following numbers of plots: 57 Sitka spruce (*Picea sitchensis* (Bong.) Carr.), 52 Norway spruce (*P. abies* (L.) Karst.), 81 Scots pine (*Pinus sylvestris* L.), 86 oak (*Quercus* spp.) and 65 beech (*Fagus sylvatica* L.). There were also three plots in mixed stands of Sitka spruce and Scots pine. The assessments were carried out between 16 June and 14 September 2004.

Plots consist of 24 trees located in four sub-plots of six trees and, depending upon the species assessed, between 29 and 33 features indicative of condition are scored for each tree. Evaluations of the incidence of flowering and fruiting, or the incidence of damage by insects or fungi are therefore made, but the feature of greatest interest is an assessment of crown density. This is an estimate of the degree of opacity of the crown, which is used as an index of tree condition. Until 1993, the basis for comparison used in the surveys conducted in the United Kingdom 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 standard against which the plot trees are assessed. The same local tree is generally retained from year to year but 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 in the United Kingdom have been made using the local tree method since 1993. However, to maintain the existing time series of crown density figures, all plot trees have also been assessed using the previous idealised standard.

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. Except where otherwise stated, the crown density results presented here are those obtained by comparison with an 'ideal' standard.

To check the consistency of the crown density scores made by the 16 teams of assessors involved in the survey, 107 plots were re-assessed by two experienced supervisors*. The proportion of trees for which the scores of the assessors and supervisors fell within one 5% class ranged from 85.9% in oak to 91.3% in Sitka spruce. The corresponding figures for two class limits (10%) were 98.1% for Scots pine and 99.8% for Sitka spruce. Since

*The assessments of the supervisors were also checked against each other in a separate exercise and were not found to differ significantly for any of the surveyed species.

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. The mean difference between the scores of the assessors and the supervisors exceeded 5% for only one of the 58 team/species combinations tested.

THE 2004 RESULTS

The 2004 results are presented here in terms of crown densities rather than the crown density reductions reported for the forest condition surveys undertaken between 1987 and 2001. For an explanation of this change, and of how to convert the current figures to crown density reductions, the report of the 2002 survey should be consulted (Hendry *et al.* 2003).

The marked effect of using a local reference tree rather than an ideal tree as a standard for comparison can be seen in Table 1, where the results obtained in 2004 using both methods of crown density assessment are presented. A greater proportion of trees receive low density scores when compared with an 'ideal' rather than a 'local' standard. This difference can largely be accounted for by variations in the 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 tend to have a more open appearance (i.e. a lower crown density) than the older trees illustrated in Innes (1990). Some older oaks and spruces also have a naturally open structure. The crown density scores allotted to trees like these are much lower when compared with an ideal tree than when judged against local trees of the same age and form.

Figure 1 shows the changes in crown condition that have taken place since 1987. A *downward* gradient in this figure indicates a *deterioration* in crown condition. Alterations in condition compared with last year were minor for all of the surveyed species except beech, the crown density of which deteriorated markedly compared with 2003. However, the crown condition of beech has fluctuated widely over the entire 18-year survey period and the species displays no overall trend for deterioration or improvement. Similarly, no long-term trends in the condition of either Sitka spruce or Scots pine are apparent.

Analysis of the 1987–2004 data indicates that statistically significant deteriorations in the crown densities of both Norway spruce and oak have occurred over the duration of the survey. The time series are relatively short and the indicated rates of change are small, however, with average reductions in crown density of 0.45% per annum in oak and 0.31% per annum in Norway spruce. The magnitudes of past increases in the crown density of Norway spruce suggest that a single year of improvement could nullify the trend currently displayed by this species. In contrast, a number of seasons of improvement in condition would be required to negate the long-term trend for deterioration in oak which has been apparent since 1999 (Redfern, Boswell and Proudfoot, 2000). Caution should be exercised when interpreting the indicated deterioration, however, since it is heavily influenced by the high crown density values recorded for oak in the period 1987 to 1990 when the number of survey plots of this species was relatively low.

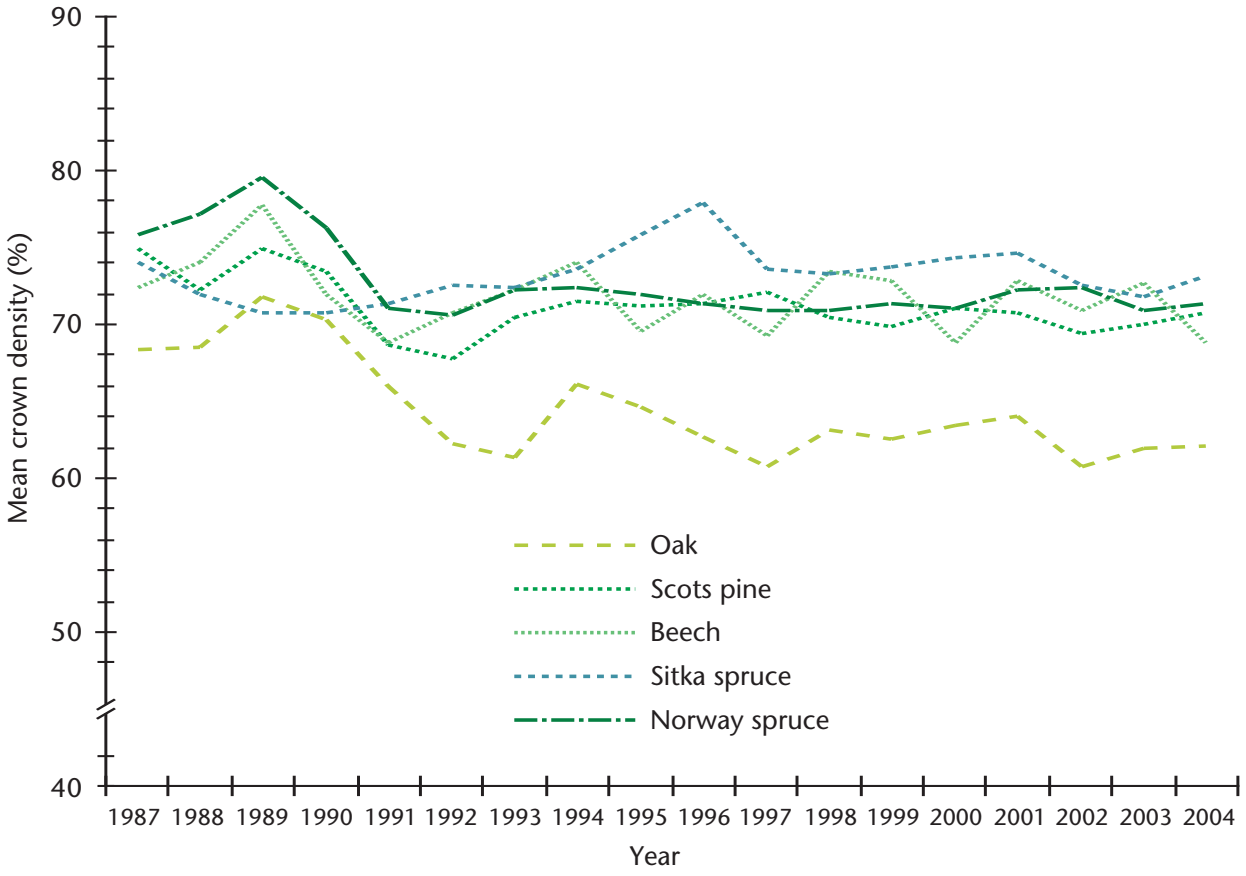
Since 1991 the mean crown densities of Norway spruce, Sitka spruce and Scots pine have increased by 0.2%, 1.7% and 2% respectively. In the cases of Norway spruce and Scots pine, these relatively minor improvements in condition are a reflection of the very small inter-annual fluctuations in crown density which have occurred over the past 13 years. However, Sitka spruce has displayed much greater variations in condition over the same period. Incremental improvements in crown condition over a number of consecutive years have been punctuated by marked deteriorations in particular growing seasons. The last notable decrease in the crown density of Sitka spruce occurred in 2002 and a further slight deterioration in its condition occurred in 2003. In 2004, this decline was reversed and the species displayed its largest annual increase in crown density since 1996. The condition of oak also improved slightly this year but it has yet to recover from the marked deterioration in condition which occurred in 2002.

Figure 2 shows the geographical variation in crown density for each of the assessed species. The condition of beech was variable but was poorer than in 2003 across much of central England. Crown densities in the southern parts of the East Midlands and the western parts of east England were notably lower than in recent years. The condition of Scots pine tended to be in better in the region south of the Humber–Mersey line than elsewhere, although trees in northwestern England and northeastern Scotland also displayed relatively high crown densities. Whilst the condition of Norway spruce appeared to be poorer in the western half of southeast England and in the East Midlands than in the remainder of southern Britain this impression is created by relatively few plots and there

Table 1 **Percentages of trees in each crown density class for five species in 2004.** Each 10% class represents the density of the tree's crown compared either with an 'ideal' tree, i.e. a tree with the maximum possible amount of foliage, or with a 'local' tree, i.e. a tree with full foliage under local conditions.

% crown density [% reduction in crown density]	Sitka spruce		Norway spruce		Scots pine		Oak		Beech	
	Ideal	Local	Ideal	Local	Ideal	Local	Ideal	Local	Ideal	Local
90–100 [0–10]	8.4	24.4	5.9	26.0	4.3	27.5	0.9	17.4	1.4	27.5
80–89 [11–20]	26.8	34.1	27.3	37.4	24.6	39.3	9.3	30.2	22.0	38.9
70–79 [21–30]	36.3	26.7	36.1	22.8	39.7	21.6	26.7	28.7	35.1	21.5
60–69 [31–40]	20.7	10.5	20.8	9.0	23.6	7.3	35.7	13.9	29.0	7.8
50–59 [41–50]	5.6	2.5	6.1	2.2	4.5	2.1	15.2	4.8	7.7	2.2
40–49 [51–60]	0.9	0.9	1.0	0.5	1.3	0.5	7.0	1.9	2.8	1.1
30–39 [61–70]	0.5	0.4	0.9	0.7	0.5	0.2	1.8	0.8	1.0	0.3
20–29 [71–80]	0.4	0.2	0.5	0.2	0.2	0.3	1.1	1.0	0.3	0.3
10–19 [81–90]	0.1	0.0	0.2	0.0	0.1	0.1	1.1	0.3	0.3	0.1
0–9 [91–100]	0.3	0.3	1.2	1.2	1.2	1.1	1.2	1.0	0.4	0.3

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



is considerable local variation in the condition of the species. Sitka spruce displayed no clear pattern. As in previous years, the crown density of oak displayed considerable variation but was poor in southern and central Scotland, south Wales and the western parts of East England. The condition of trees was particularly poor in central Scotland, where high levels of insect defoliation have been recorded in oak for several consecutive surveys.

FACTORS AFFECTING CROWN CONDITION IN 2004

The late summer and autumn of 2003 were very dry, with rainfall in October being only 60% of the long-term average. Conditions from November until mid-February 2004 were milder and wetter than normal in most parts of the country, although heavy snowfalls and blizzards occurred in northern Britain in late December and early January resulting in physical damage to the crowns of conifers at certain locations. Widespread and occasionally damaging snowfalls also occurred towards the end of February. Following a dry and warm but occasionally stormy March, mild and wet weather predominated in April and early May and damaging spring frosts were consequently rare. With rainfall near or above average for the remainder of the 2004 growing season and temperatures being generally warm, conditions for tree growth were good. Localised extremes of weather that were injurious to trees did occur during this period, however. Notably, the heavy hail storms which occurred in the southeast of England in mid-July and early August were sufficiently severe to cause foliar damage to a range of broadleaved trees.

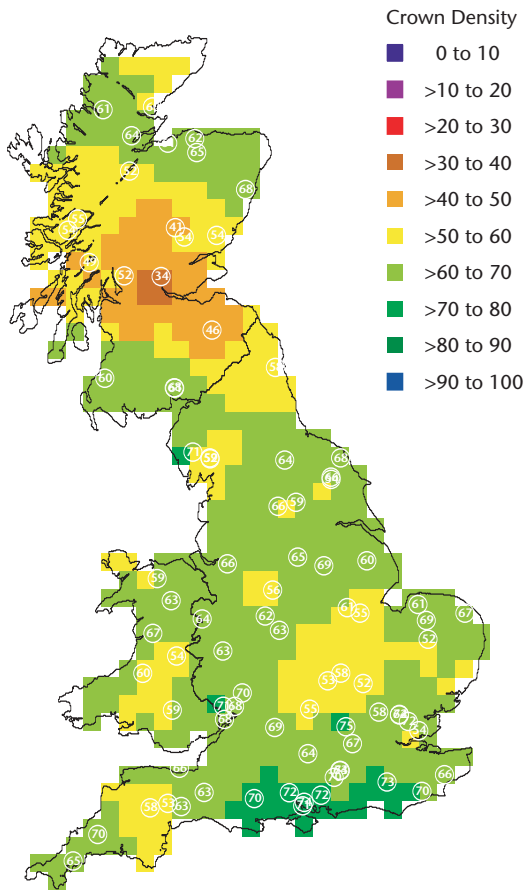
The deteriorations in condition suffered by Sitka spruce in 2002 and 2003 (Hendry *et al*., 2003; 2004) were partially offset by an increase in the crown density of the species in 2004. This improvement was largely attributable to a marked decrease in both the incidence and severity of damage caused by the green spruce aphid *Elatobium abietinum*. Whilst signs of current or old aphid attacks were reported from 45 plots in 2003, the insect was active in only 25 survey plots in 2004. The proportion of trees displaying new insect damage had correspondingly decreased from 30.5% in 2003 to 16.5% this year. Damage due to *Elatobium* is often manifest as a browning of the older needles and the percentage of surveyed trees which displayed this symptom also decreased from 22.6% in 2003 to 9.3% this year. In spite of these improvements, the recovery of trees defoliated by aphids in 2002 and 2003 is unlikely to be complete for several growing seasons.

The condition of oak has improved in four of the past five years but, in spite of this, its crown density is lower now than in 1999 due to the magnitude of the deterioration which occurred in 2002. The most important damage to oaks in 2004 was caused by defoliating and leaf-mining insects, the actions of which were recorded in 85 of the 86 plots assessed. However, such damage was generally light and insect attack was recorded as common or abundant on only 17.5% of the assessed trees. Heavy or severe attacks by the winter moths *Operophtera brumata* and *Erannis defoliaria* were confined to only seven plots, all of

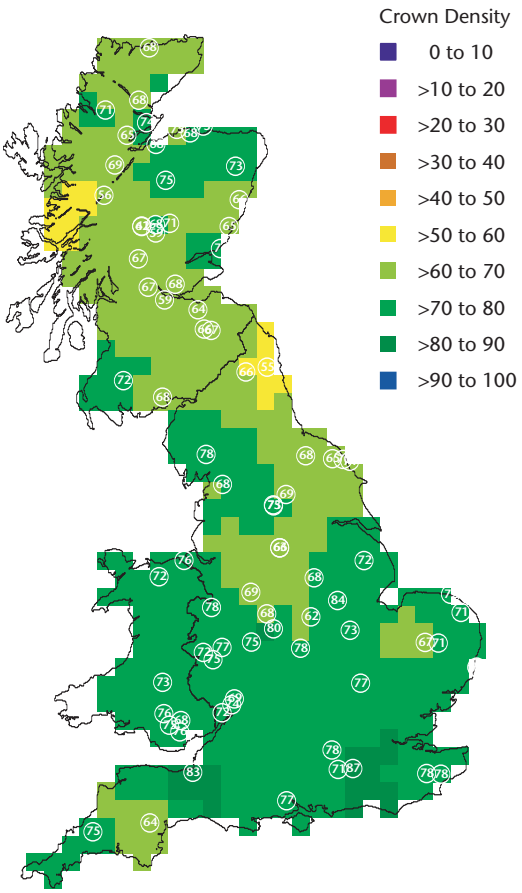
Figure 2

Geographical variation in crown density for five species in 2004. White circles show the locations of plots, and figures within the circles are mean crown densities (%). 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.

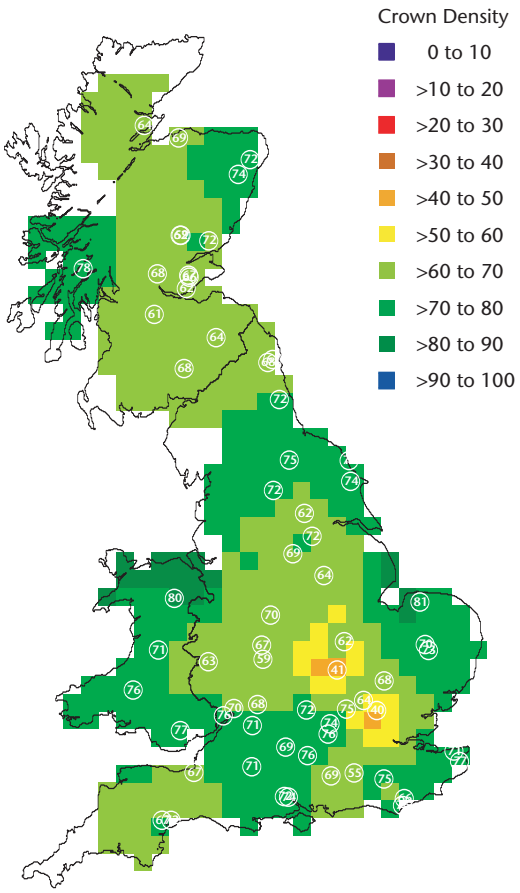
Oak 2004



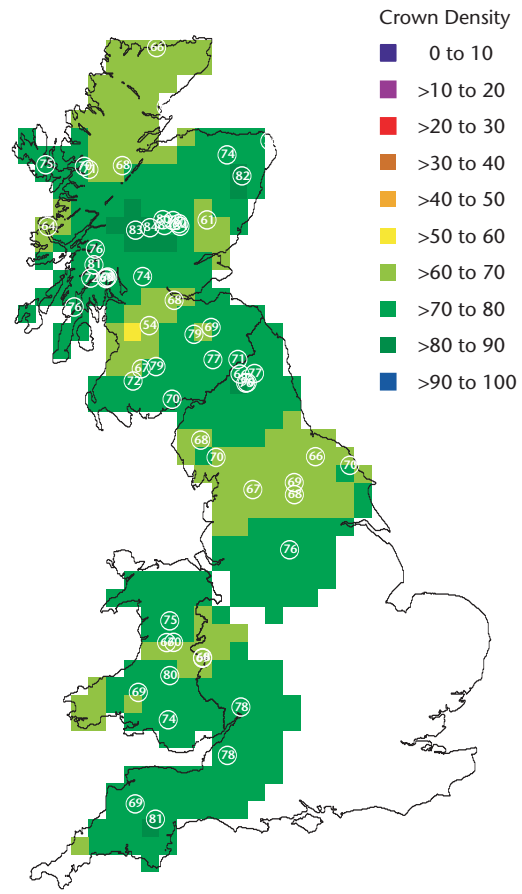
Scots pine 2004



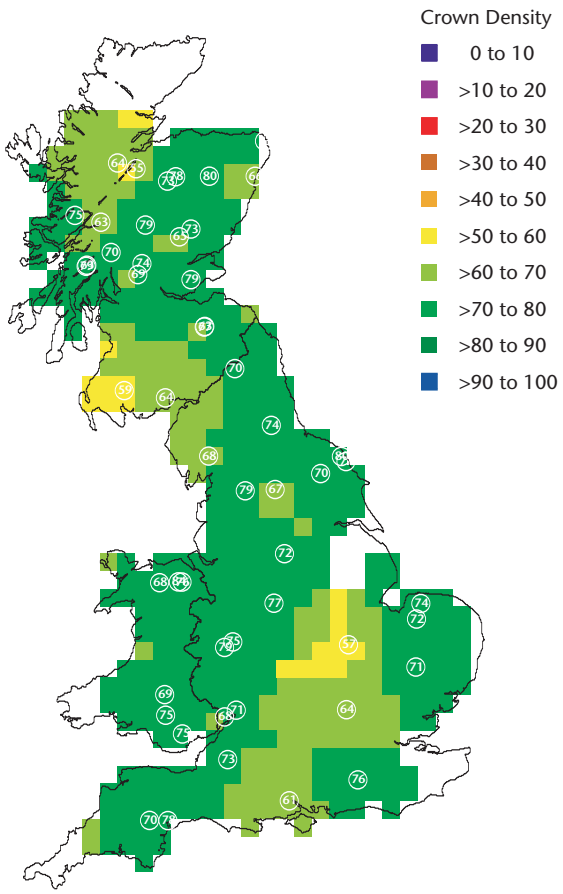
Beech 2004



Sitka spruce 2004



Norway spruce 2004



which were in Scotland. Recent storm damage influenced the crown condition of trees in several plots located in the areas of southern and eastern England affected by severe hailstorms in July and August. Elsewhere, oak dieback (Gibbs, 1999) of long standing was identified as the cause of the poor condition of five plots and severe new dieback was recorded in a further two plots.

In common with previous cases of decline recorded in 1990, 1995, 2000 and 2002, the deterioration in the condition of beech which occurred in 2004 was largely associated with heavy fruiting. Mast production was noted on 89.7% of the surveyed trees and was recorded as heavy (assessed by the surveyors as being 'common' or 'abundant') in 78.6% of the population. A reduction in leaf size, which sometimes accompanies fruiting, was noted on 25.4% of trees in 2004 compared with the 3.6% of trees which displayed this attribute in 2003. Although premature leaf loss was less prevalent than last year, it was still recorded on 15.9% of the surveyed trees suggesting that recovery of beech from the abnormally dry summer of 2003 may not yet be complete. Damage from insects was generally light this year with attack being recorded as absent, rare or slight on 87.5% of trees. No other forms of damage were significant.

Changes in the crown densities of Norway spruce and Scots pine were minor this year, continuing the pattern of little variation which has held for both species since 1991. In 2004, defoliation of Norway spruce by *Elatobium abietinum* occurred in nine plots but the extent of damage was minor in all cases. Fungal damage was largely restricted to cases of bud blight caused by *Cucurbitaria piceae* which was only adjudged to have had an adverse effect on the crown densities of a few trees. With 24% of the surveyed population producing cones, fruiting in Norway spruce was more common this year than at any time since 1996. However, increased production of cones has no deleterious effect on the crown condition of this species and, because cones tend to be concentrated near the apex of the crown, may even give the tops of trees an appearance of increased density. The proportion of Scots pines retaining their needles for three or more years increased from 32.9% in 2003 to 64.8% in 2004 and this change might have been expected to result in a larger improvement in crown density than was actually exhibited by the species. Marked increases in the incidence both of male flowering on the 2004 shoots and of wind damage to pine crowns served to offset the effect of increased needle retention, however.

CONCLUSIONS

Rainfall was well distributed throughout the 2004 growing season in most parts of the United Kingdom and conditions for tree growth were generally good. Heavy snowfalls in early January and late February, high winds in March and severe hailstorms in mid-July and early August all resulted in localised damage to the tree species assessed in the survey. Changes in condition were minor in oak, Scots pine and Norway spruce this year but beech exhibited a sharp decline, and Sitka spruce a marked increase, in crown density. A slight improvement in the condition of Scots pine was largely related to increased needle retention. Levels of insect damage to oak were generally low this year and the crown density of the species increased slightly. However, in spite of displaying improvements in four of the past five years, it has not yet fully recovered from the sharp decline in condition which it suffered in 2002. In common with previous years, the crown density of Norway spruce fluctuated only slightly in 2004 and its condition has remained virtually unchanged since 1991. The sharp decline in the condition of beech which occurred this year was chiefly associated with heavy mast production and is not necessarily an indication of poor health. Severe defoliation by the green spruce aphid resulted in deteriorations in the crown condition of Sitka spruce in both 2002 and 2003. However, the incidence and severity of attacks by the insect were reduced this year and a distinct improvement in the condition of the species resulted.

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