The Forestry Authority
Forestry Commission

Research Information Note 262

Issued by the Research Division of the Forestry Authority

FOREST CONDITION 1994, by Derek Redfern, Roger Boswell and John Proudfoot

Abstract

Crown density and a variety of other features were assessed on a total of 8808 trees of five species – Sitka spruce, Norway spruce, Scots pine, oak and beech – distributed over 367 plots. Since 1993 there has been an overall increase in the crown density of all species, which continues an improvement observed in three species the previous year. Improvement was most marked in oak, in which a continuous decline since 1989 only ceased in 1993. Except for 1989, beech was in better condition than at any time during the last eight years.

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 1994, a total of 8808 trees was assessed distributed over the following numbers of plots: 70 Sitka spruce (*Picea sitchensis* (Bong.) Carr.), 73 Norway spruce (*Picea abies* (L.) Karst.), 80 Scots pine (*Pinus sylvestris* L.), 82 oak (*Quercus* spp) and 62 beech (*Fagus sylvatica* L.). The assessments were carried out between 27 June and 1 September 1994.

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. In order to harmonize with results obtained in other countries, crown density estimates were made using the local tree method in 1993, and again this year. However, in order to maintain the existing time series of crown density figures, all plot trees were also assessed using the previous idealised standard. The results obtained by these two methods in 1993 are compared by Redfern *et al.* (1994).

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.

The 1994 results

4. 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.

5. 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%. An upward gradient in Figure 1 would therefore indicate a deterioration in crown condition. 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 common for all five species.

6. The general improvement in crown condition which began in 1993 continued this year. Improvement was most marked in oak, in which a continuous decline since 1989 only ceased last year. The recovery of beech has been maintained and, other than the peak year of 1989, it is in better

Table 1 Percentages of trees in each crown density class for five species in 1994. 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.

Percent 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	47.5	13.5	39.5	5.9	39.7	3.1	38.4	7.0	51.0
11–20	28.7	33.3	29.3	33.2	25.3	34.7	17.5	34.6	33.1	34.8
21–30	31.6	12.3	30.3	15.3	38.0	18.5	27.7	17.0	37.0	10.1
31–40	16.4	4.3	14.2	5.3	21.6	4.6	29.4	6.6	17.5	2.6
41–50	6.4	1.3	5.4	3.0	6.5	1.2	13.5	2.2	3.6	0.9
51–60	2.1	0.7	2.7	1.5	1.4	0.3	5.5	0.6	0.9	0.3
61–70	1.2	0.4	1.5	0.5	0.5	0.1	1.8	0.3	0.6	0.1
71–80	0.8	0.1	1.0	0.2	0.2	0.3	0.8	0.2	0.3	0.0
81–90	0.1	0.1	0.5	0.4	0.2	0.2	0.6	0.1	0.0	0.0
91–100	0.1	0.0	1.5	1.3	0.6	0.4	0.2	0.1	0.1	0.1

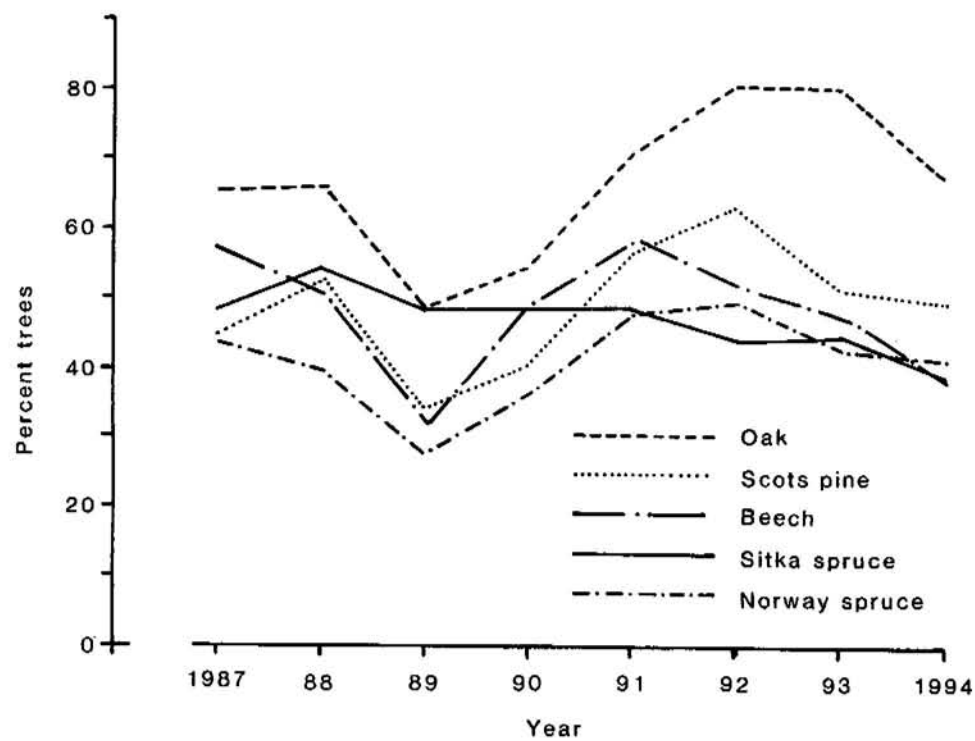

Figure 1 Changes in crown density since 1987 for five species surveyed annually. The proportion of trees in which crown density was reduced by more than 25% compared to an ideal tree is shown for each species.

condition than at any time since 1987. Among the conifers, Scots pine has shown the greatest improvement since 1992. Nevertheless, its crown density is apparently still lower than that of either Norway spruce or Sitka spruce. This may be due largely to the naturally open structure of the crown, particularly in young trees. This effect is compensated for by use of local reference trees as standards for comparison, and on this basis the crown density of Scots pine lies between those for Norway spruce and Sitka spruce. Surprisingly the improvement in crown density between 1992 and 1994 was not related to needle retention, a feature which can be assessed quite accurately in Scots pine. In both years the overwhelming majority of trees retained needles for either two or three years. However while needles of these ages were held in roughly equal proportions in 1992, the proportion of trees with three-year-old needles in fact fell slightly in 1994. The improvement may have been due to an increase in shoot length and needle length. These parameters are not assessed in the survey but are known to respond to growing conditions.

Factors affecting crown condition in 1994

7. A wet winter and adequate summer rainfall, in most parts of the country, were probably the most important beneficial factors affecting crown density this year. Neither wind nor snow was a significant cause of damage to crowns although one Norway spruce plot was destroyed by windblow. However, breakage caused by earlier events still affects some trees.

8. The general condition of Norway spruce has remained virtually unchanged since 1991. However, the lethal condition known as 'top-dying' was recorded as a significant cause of damage in seven plots. This is a progressive, climatic/physiological disorder associated with wind and drought. One plot has shown a steady deterioration since 1991: initially this involved a reduction in crown density but since 1992 seven out of 24 trees have died. On older trees the bud blight fungus *Cucurbitaria piceae* (*Gemmamyces piceae*) was recorded in a number of plots causing some crown distortion.

9. As noted in earlier reports (Redfern *et al.*, 1993; 1994), crown density in Sitka spruce is largely determined by attacks by the green spruce aphid (*Elatobium abietinum*), although crown thinning is also associated with increasing age and exposure. The slight but steady improvement since 1988 may reflect a lessening of large-scale damage by this insect since the 1988–90 outbreaks reported by Innes and Boswell (1991).

10. The only significant factors reducing crown density in Scots pine were the persistent effects of damage caused by gales and snow in 1990 and damage by squirrels and the bark beetle *Tomicus piniperda*. The effects of most other agents were minor. These included *Lophodermium seditiosum*, *Brunchorstia pinea* (*Gremmeniella abietinia*), *Peridermium pini* and exposure.

11. On beech only slight effects of beech leaf minor (*Rhynchaenus fagi*), squirrels, *Nectria* canker and past wind damage were noted. There was some yellowing of leaves in the upper crowns of trees on three plots in the south of England, and in early September similar yellowing was observed on non-plot trees in East Anglia. The cause is unknown but possibilities include lime-induced chlorosis, ozone and local drought.

12. In spite of considerable improvement, oak is still in poorer condition than any of the other species surveyed. As in the past, this seems to have been due largely to insect damage; plots with low values for crown density were generally those in which insect activity was noted as heavy or severe. Defoliation, which may be virtually total in some trees, occurs early in the growing season and may be caused either by the oak leaf roller moth (*Tortrix viridana*) or by various winter moths such as *Opheroptera brumata* and *Erannis defoliaria*. The latter two species caused severe defoliation in several plots in Scotland. After larval feeding is complete a significant degree of recovery may take place later in the growing season, when the survey is carried out. Discolouration (browning and yellowing of leaves) was reported from a number of plots. This was probably due to a combination of oak mildew (caused by the fungus *Microsphaera alphitoides*) and leaf mining by insects. The fungus *Apiognomonia errabunda* was identified as the cause of browning on one plot. The only other significant factor affecting crown density was past damage by gales. There is a serious and unexplained condition known simply as oak decline which occurs in south and east England (Greig, 1992) but this was found only in three plots and was severe only in one of them.

13. Geographical differences in crown density are difficult to determine due to the uneven distribution of some species. However, in spite of this limitation interpolated maps of the data show that the crown density of Sitka spruce was generally higher in the north than in the south whereas the reverse was true for oak.

14. It should be noted that, for a variety of reasons, individual trees in hedgerows and on roadsides, particularly beech and oak, may be in much poorer condition than the woodland trees included in this survey.

Conclusions

15. 1994 was generally a good year for tree growth and there has been an overall increase in the crown density of all species, continuing an improvement noted for three species in 1993. Improvement was most marked in oak, in which a continuous decline since 1989 only ceased last year. The recovery in beech which began in 1992 has been maintained so that, except for the peak year of 1989, this species is now in better condition than at any time during the last eight years. Among the conifers, Scots pine has shown the greatest improvement since 1992. Since 1987 crown density has fluctuated either annually or on a slightly longer cycle, revealing little evidence so far of a long-term trend. The results are consistent with variations in crown density caused by a number of well-known biotic and climatic factors.

Acknowledgements

16. We are grateful to staff from the Forestry Commission's Surveys Branch and Mensuration Branch who carried out this work so conscientiously and efficiently, and to Lesley Halsall and Heather Steele for help with processing and collating the results. We would also like to thank Forest Enterprise district managers and private woodland owners for their help in setting up and maintaining the survey plots.

References

GREIG, B. J. W. (1992). *Occurrence of decline and dieback of oak in Great Britain.* Research Information Note 214. Forestry Commission, Edinburgh.

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. C. and PROUDFOOT, J. C. (1993). *Forest condition 1992.* Research Information Note 236. Forestry Commission, Edinburgh.

REDFERN, D. B., BOSWELL, R. C. and PROUDFOOT, J. C. (1994). *Forest condition 1993.* Research Information Note 251. Forestry Commission, Edinburgh.

Issued by:
Research Publications Officer
The Forestry Authority, Research Division
Alice Holt Lodge, Wrecclesham
Farnham, Surrey GU10 4LH

March 1995

ISSN 0267 2375

Phototypeset and published by: Forestry Commission, 231 Corstorphine Road, Edinburgh EH12 7AT