This note is no longer in print but the text below was that used in the published manuscript.

Research Information Note 275
Issued by the Research Division of the Forestry Commission

NATURAL REGENERATION OF BROADLEAVED TREES, by Ralph Harmer and Gary Kerr

Summary

A survey of 78 sites in southern England with plans for natural regeneration approved under the Woodland Grant Scheme showed that level of success was often less than could be achieved by the use of best practice. The main problems were a lack of seed trees on the site with regeneration fellings occurring before the appearance of sufficient regeneration, failure to protect seedlings from damage by mammals and an absence of effective weed control. The advice provided in Forestry Commission Bulletin 78 *The natural regeneration of broadleaves* remains valid with some revision to advice on ground preparation.

Introduction

1. Natural regeneration describes the establishment of trees and woodlands from seeds produced and germinated *in situ*. It covers both restocking of existing woodland and the extension of woodlands onto previously unwooded areas.

2. Natural regeneration may be more desirable than planting because it can conserve local genotypes, create more diverse woodlands and produce a wide choice of stems for selection. Following the 1994 revision of the Woodland Grant Scheme the Forestry Authority is promoting the use of natural regeneration wherever it is both practical and appropriate. However, it can be unpredictable, and sometimes difficult and expensive to achieve. For example, Benezit (1991) quotes a cost of £2000 per ha for the natural regeneration of oak high forest in Normandy, France because of the need for intensive management, particularly weeding and protection from damaging mammals.

3. This Note gives results from the survey and provides information and advice on the use of natural regeneration to restock existing broadleaved woodlands. It is based on existing published information (Evans, 1988) modified by detailed observations made during 1993 and 1994 at 78 sites in southern England approved for natural regeneration under the Woodland Grant Scheme.

4. The survey investigated a variety of site factors including the species, numbers and approximate age of parent trees, the type and quantity of ground vegetation, seedling numbers and size, and browsing damage. A preliminary analysis of data collected at 25 sites in 1993 has already been undertaken (Harmer *et. al*., 1994); further analysis of the full dataset is now in progress.

Use of natural regeneration in Britain

5. Interest in the use of natural regeneration as a method of restocking has been increasing in Britain since the announcement of the Government's broadleaves policy in 1985. Before this, the use of natural regeneration was mainly restricted to established estates such as Ebworth, Longleat, Cirencester Park, and informal colonisation of waste ground. Most foresters, consultants and woodland advisers have had little training in or experience of natural regeneration and consequently lack confidence in the application of the system. Written information and practical

advice is usually based on continental methods which may be inappropriate under British conditions.

6. There are no generalised prescriptions for success: different species, soil types and woodlands require different treatments. Successful procedures will usually need a detailed knowledge of each woodland (e.g. seed production, presence of advance regeneration, browsing) and an understanding of how species will respond to management. This is unlikely to be achieved by foresters who spend little time making observations in the field.

Site conditions

7. Although most sites protected from mammals will eventually regenerate to woodland, the speed with which regeneration happens will depend not only on the sources of seed available and the type of weeds present but also on the physical conditions of the site. Natural regeneration is often more difficult on moisture-retaining, heavy and fertile soils than on those which are light, dry and infertile.

Seed sources

8. The frequency of viable seed production varies with species and, for common trees, declines in the order birch>sycamore = ash>oak>beech. The quantity of seed produced varies with the size of tree, large trees of each species producing the most seed. Regeneration is likely to be good in woodlands where crown thinnings have developed well balanced crowns on dominant trees. Conversely, regeneration is less likely in over-thinned or felled areas retaining a sparse cover of trees with poor crowns which produce few seeds. At all sites visited during the survey there was evidence of seed production by one, or in the majority of cases, many species.

9. The mobility of seed varies with species and site. In open conditions light wind-borne seeds of birch and willow may travel over 100 m and heavy wind-borne seeds of ash and sycamore tens of metres; distances are much reduced within a stand. Although heavy seeds can be dispersed by animals, most seeds of species such as oak, beech and chestnut remain close to the parent tree.

10. To maximize the probability of successful natural regeneration, silvicultural practices should aim to produce a stand in which seed trees are evenly distributed across the site. The number of seed trees required will vary with species: fewer will be needed for wind dispersed species that fruit regularly than for heavy-seeded, irregularly fruiting species. Thus for oak and beech a higher proportion of final crop trees should be seed bearers than for birch or ash. Thinnings before regeneration must not remove the best seed-bearing trees.

Advance regeneration

11. Advance regeneration is the term given to seedlings that are present beneath the canopy before regeneration fellings occur; the amount varies with species, site and past management. Species such as ash, which fruit regularly and have shade tolerant seedlings, are often very abundant and on small areas of some sites the estimates of ash seedling numbers exceeded 250 000 per ha. In contrast, light demanding species such as oak, which also suffers from mildew and is often defoliated by insects, will often do poorly in the low light levels beneath the canopy.

12. Advance regeneration was present at all sites visited during the survey, the minimum stocking density was 100 seedlings per ha but was generally several thousand per hectare. Generalisations are difficult, but where advance regeneration was present, the abundance of common species declined in the order ash>sycamore>beech = oak>birch.

13. Many seedlings were in their first year of growth and less than 15 cm tall; those that were larger were often browsed. Few sites had many seedlings 30-200 cm tall.

14. The presence of advance regeneration is the most reliable indicator of likely success and management should aim to encourage the development of well established seedlings prior to regeneration fellings. This will probably be easier for ash than for other species.

Competitive weeds

15. In many naturally regenerated continental woodlands, years of careful management have resulted in only a sparse ground flora. In contrast, many British woodlands have a well developed ground flora of competitive plants which can adversely affect seedling growth.

16. The type and quantity of vegetation present varies with site and depends on factors such as soil, moisture availability, tree species and canopy cover. Fertile, moisture retentive soils with poor canopy cover usually support a more luxuriant ground flora than freely drained, infertile soils with good canopy cover. In general, natural regeneration is more successful on sites where growth of competitive vegetation is poor.

17. Maintaining canopy cover is an important method of vegetation control, but on many of the sites visited in the survey there was low canopy cover and a luxuriant growth of weeds. As the light requirements for seed germination and early growth are generally lower than those required for full establishment, the woodland canopy can be maintained at quite high levels in the early stages of regeneration to control competing vegetation.

18. Tall, dense vegetation of any description was rarely associated with substantial regeneration. This was particularly noticeable in areas of tall, continuous cover of bramble, bracken and dog's mercury: natural regeneration is unlikely to be successful on sites where these species are abundant before regeneration fellings take place. No evidence of effective weed control designed to encourage natural regeneration was seen.

19. Generalisations concerning the competitive ability of different tree species cannot be made, but oak does appear more able to grow in a grass sward than the other common species. In addition, advance regeneration is more likely to survive weed competition than new seedlings.

20. Silviculture should aim to suppress weeds by maintaining good canopy cover of both under- and over-storey shrubs and trees. Removal of too much canopy during regeneration fellings will often encourage the growth of weeds making conditions unfavourable for the establishment and growth of young seedlings. Changes in vegetation following regeneration felling and their likely effect on seedling growth should be assessed before opting for restocking by natural regeneration.

Ground preparation

21. Continental literature often recommends ground preparation to enhance natural regeneration; this gives some degree of weed suppression, decreases the chances of seed predation and provides better sites for seed germination in the mineral soil. These practices can be beneficial for oak and beech on sites with deep layers of litter, such as beech growing on poor clay soils in the Chilterns. On other sites or where other species are being regenerated, ground preparation should only be used with great care.

22. Ground preparation will damage existing advance regeneration, disturb existing plant

communities, produce soil conditions suitable for invasion by seeds of all species including weeds and may stimulate the germination of dormant seeds in the soil. It is unlikely to have a long-term effect on the growth of perennial weeds such as bracken and bramble.

23. Our observations indicate that thin dry chalky soils should be disturbed as little as possible during forest operations, otherwise rank herbaceous weeds replace the existing natural vegetation that appears to be favourable for natural regeneration.

Animals

24. Although birds and small mammals may aid the dispersal of species such as oak, holly and hawthorn the effects of animals on regeneration of most trees are predominantly harmful, seeds being eaten and young trees damaged by browsing and fraying.

25. The effect of seed predation varies with species, the large seeds of beech and oak being more susceptible than smaller seeds such as those of ash.

26. Whilst caches of acorns buried by some animals may grow to produce seedlings those buried by grey squirrels will not germinate as their embryo is usually destroyed before burial. Natural regeneration of oak is likely to be enhanced where grey squirrels are carefully controlled; see Pepper (1990) for guidance on methods of grey squirrel management.

27. Browsing damage was seen at almost all sites where seedlings more than one year old were present; the species of animals responsible were not determined but evidence of deer, rabbits or both were usually seen. In many woods browsing is probably the most significant factor preventing the development of advance regeneration.

28. The level of browsing and the animals responsible must be assessed before deciding on the appropriate method of restocking. Unless browsing damage can be reliably contained at very low levels by strictly controlling the size of rabbit and deer populations over the entire period of regeneration, then the only satisfactory method of protection is to isolate completely the regenerating seedlings from browsing animals. This may be by appropriate fencing (Pepper, 1992) or the use of treeshelters (Potter, 1991).

29. Domestic and agricultural livestock must be fenced out.

Management

30. Successful natural regeneration is most likely in woodlands where the long-term management aim is to restock by natural regeneration and adequate measures are taken to secure the seedling crop.

31. Short-term treatments to aid regeneration were scarcely seen: few sites had a fence of any description; individual protection of regenerating seedlings was rarely observed; and weed control was almost non-existent and usually associated with small group plantings in the area of regeneration.

32. Successful natural regeneration in continental forests follows many years of careful silviculture. In contrast, most of the woodlands visited during the survey had received no long-term management designed to encourage natural regeneration. It was often being attempted where conditions were unfavourable.

33. Woodlands are often managed for game which provides an important source of income. Feeding points will encourage high populations of squirrels and other small mammals that will eat tree seeds. The population of deer needed to provide good stalking will prevent successful natural regeneration unless adequate protection is used. Natural regeneration is most likely to succeed in well managed woodlands where there is no sporting interest and good squirrel and deer control.

34. The control of browsing damage should often begin several years before regeneration occurs. This will allow establishment of advance growth and is most appropriate on heavy, fertile soils, where large established seedlings will compete more successfully with the vigorous weeds that inevitably grow following the seeding felling.

Recommendations

35. Many foresters believe that there are biological and climatic reasons why good regeneration cannot be achieved in Britain. However, the main conclusion of the survey was that **all** sites visited had the potential for restocking by natural regeneration. Despite this potential, excessive browsing and weed competition are likely to cause many failures. Each woodland and each species needs individual treatment, but success is most likely in these circumstances.

- The long-term management aims are to restock by natural regeneration.
- Felling follows the appearance of good regeneration rather than felling with the hope that regeneration will appear.
- Regular thinning has produced good seed bearing trees which are evenly distributed across the site.
- The process of regeneration has been preceded by a careful study of the woodland; predictions of the changes which are likely to occur during regeneration have been made before the formation of appropriate plans.
- The best seed-bearing trees are not removed unless satisfactory numbers of well established seedlings are already present.
- Browsing damage is prevented in the years before and after regeneration felling.
- Ground preparation is used with care: it can be useful on sites with a deep litter layer, but it is probably inappropriate elsewhere.
- The growth of competitive weeds is controlled.

36. Natural regeneration is neither a cheap nor an easy option. Success is most probable on sites having a continuous canopy formed by evenly distributed, dominant, seed-bearing trees that stand over large amounts of unbrowsed, advance regeneration. It will be very difficult to achieve on some sites and planting may be the most appropriate option.

References

BENEZIT, J.J. (1991). Soils and regeneration in Normandy. *Quarterly Journal of Forestry*, **85(1)**, 30-37.

EVANS, J. (1988). *Natural regeneration of broadleaves*. Forestry Commission Bulletin 78. HMSO, London.

HARMER, R., KERR, G. and FISHER, D. (1994). The potential for natural regeneration of broadleaves in central southern England. *Quarterly Journal of Forestry*, **85(3)**, 297-302.
PEPPER, H. (1990). *Grey squirrel damage control with warfarin*. Research Information Note 180. Forestry Commission, Edinburgh.
PEPPER, H. (1992). *Forest fencing*. Forestry Commission Bulletin 102. HMSO, London.
POTTER, M.J. (1991). *Treeshelters*. Forestry Commission Handbook 7. HMSO, London.

Issued by:
Research Publications Officer — September 1995
The Forestry Commission, Research Division
Alice Holt Lodge, Wrecclesham
Farnham, Surrey GU10 4LH
 ISSN 0267 2375

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