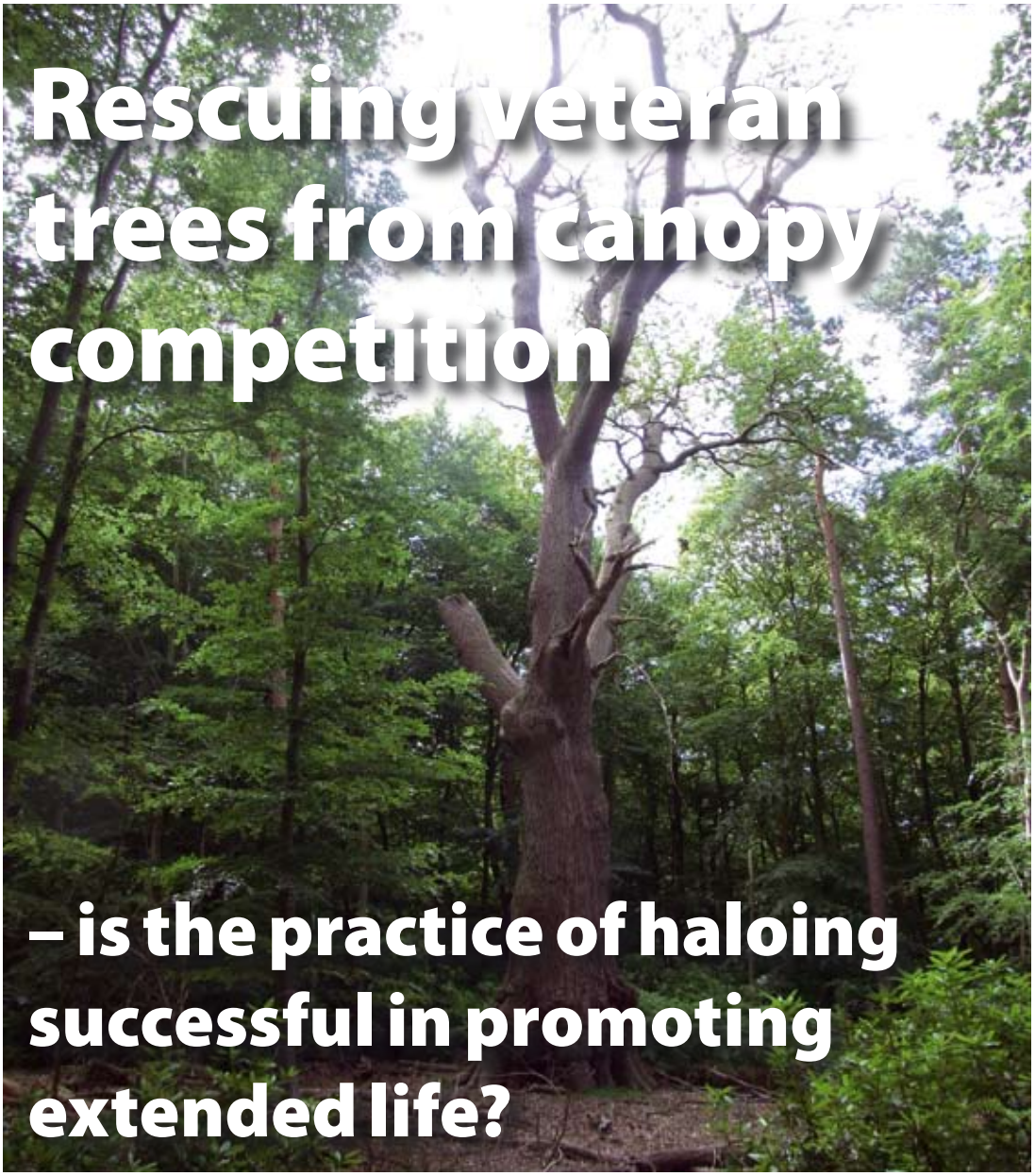
Windsor Forest is one of Britain's top sites for ancient and veteran trees, and these support a major assemblage of wood-decay fungi and invertebrates. However, many of these trees had become engulfed within forestry plantations or secondary woodland, and their survival was at risk from canopy competition. Keith Alexander, Derick Stickler and Ted Green report on a preliminary investigation of the response of selected veteran oak and beech trees to increasing light levels through clearance of the competing growth, a practice known as haloing.

Rescuing veteran trees from canopy competition – is the practice of haloing successful in promoting extended life?



↑ Caption *Keith Alexander*

In many areas of Britain, veteran trees are threatened by competition from younger, more vigorous trees. The veterans have become engulfed either in forestry plantations or secondary woodland, following abandonment of traditional grazing practices. The problems begin when the younger trees begin to grow up through and/or overtop the veterans and shade their canopy. Haloing around veteran trees has been advocated as a way of releasing the trees from competition, without causing other problems which might arise from dramatic changes in the microclimate around them. Haloing involves removing the individual younger trees from around and under the veteran which are in direct contact with the veteran's crown or lower limbs, while also in some cases leaving other younger trees growing close by in order to maintain shelter.

A large programme of haloing of ancient and veteran trees was initiated in Windsor Forest in 2003-4. The work was partly funded by the Forestry Commission, with one requirement being to monitor the success of the works. To our knowledge, no formal monitoring studies had been carried out at any site where haloing has been adopted as a conservation management technique and so the first task was to develop a trial methodology.

The specification for the haloing work covered removal of:

- All stems growing through the canopy of the old trees
- All trees with lateral branches growing into or towards the veteran's crown
- Stems overtopping the veteran's crown, to a distance of 3m from the 'drip-line'.

The trial methodology

Forty ancient and veteran oak and beech trees were selected for investigation from the interior of forest compartments during June 2010. The selection

Why release veteran trees from competition?

Woodlands tend to be bad places for trees, especially light-demanding species such as oak. The trees are over-crowded, drawn up and thin trunked, because of the competition for light with their neighbours. This is not a problem where a timber crop is the desired outcome, but is bad news for the longevity of individual trees, and hence biodiversity. Trees die young in such situations, either by felling for timber or through competition.

As trees achieve maturity they cease to grow taller, and as they age canopy retrenchment begins, and the crown 'grows downwards'. Under conditions of heavy competition, growing downwards is effectively a strategy for early death, through shading. And yet this is precisely how broadleaved trees have evolved to behave, indicating that the Wildwood was a comparatively open place, rather than the closed-canopy forest that has been proposed in the past. Trees die young in dense woodlands, which could be viewed as the ghettos of the tree world, in which individuals do not survive to reach old age. It is the aging veteran trees that developed in open-grown situations that are richest for biodiversity, hence the importance of reducing overcrowding around these trees in dense woodlands.

was made on a 'first come, first served' basis, as the trees were encountered during an exploration of the interior of the selected compartments. Oak is the commoner tree across the Forest, and this created an imbalance in the tree species investigated – 29 oak and 11 beech.

An individual tree monitoring record form was designed for use in the project; this was adjusted from experience in its use as the project progressed (see illustration, right, for an example tree in the final format). The written record was supplemented by digital photography, recording the overall tree form, the conformation of the crown, and the responses at different levels.

The signs of response were scored at three height levels on the tree, judged by eye: the crown, the middle trunk, and the lower trunk.

Typical signs of response sought were:

- reiterative growth in the middle trunk section
- epicormic growth in the lower section.

The crown response was primarily assessed in terms of viability since, in most cases, light levels would not have changed significantly at that level.

The scores used were on a scale of 1 to 10, with the actual score awarded being a subjective attempt to quantify the extent of the response, while at the same time allowing for the actual potential for a response, e.g. a tree with no obvious burry areas, and hence with limited potential for epicormic growth, was not scored for this feature. Epicormic response was scored in terms of the extent of growth and its subsequent survival; some oaks showed what appeared to be a good initial response to increased light levels, but the growth subsequently failed (possibly because of oak mildew).

Whichever was the higher of the scores for the middle and lower trunk categories was selected as the overall score for conservation benefit, as the important result was a good and viable response

Epicormic and reiterative growth

Epicormic buds are a normal feature of tree trunks and form an 'insurance policy' by being available to sprout and produce new branches following, for example, loss of the crown through storm damage or pollard-cutting. They do so in response partly to increased light levels and partly to the re-allocation of the tree's sugar reserves. The term 'reiterative growth' is used, since the new branches (sometimes together with newly stimulated pre-existing branches) have a similar growth pattern to the branches that have been lost. In many species, epicormic buds develop mainly from dormant ones, which have persisted every year since the trunk (or branch) was a year-old twig, growing just enough to stay at or just below the surface of the bark. They can, however, be adventitious, i.e. developing newly from the inner bark. The density of epicormic buds is thought to vary genetically from tree to tree, some individuals having large localised concentrations which distort the trunk's growths as burs.

Windsor Forest Tree Monitoring Project 2009

Tree Project Number 1	GPS Grid Reference 93514 74073		Location High Standing Hill		Cpt 22c
Tree Tag Number 6829	GBH 5.12m	Situation secondary beech high forest with holly			
Species oak	Date 17/6/2009	Recorder(s) KNA Alexander			
Trunk hollows Cavities in side limb stubs	Rot-holes Plenty, old branch scars	Exposed wood Branch stubs only	Aerial dead Major branch stub ends	Lying dead Sections of old brown rot on branches	Other Exposed brown rot in branch cavity
Visible signs of past haloing work Some sawn beech stumps and logged trunks					
Current condition					
Crown viability assessment 3 major top limbs, all alive and vigorous	Upper crown condition Good vigorous growth	Score 10			
	Middle crown/trunk recovery Some young branches developing	Score 5			
	Lower crown/trunk recovery Some young branches developed at points all around trunk	Score 6			
Crown competition problems Yes, surrounding beech trees touching oak canopy on all sides	Follow-up work needed High priority				
Biodiversity benefits of work					
Wood-decay fungi Brown rot visible, indicating either *Laetiporus sulphureus* or *Fistulina hepatica* active in heartwood. Brackets of *Inonotus dryadeus* visible above 10m high on trunk.					
Invertebrate habitat No invertebrate activity noted, and poor access to rot for investigation, but very high quality habitat visible.					
Conservation benefit score					
Tree condition 6	Biodiversity condition 10				
Notes on assessment A live & vigorous tree with good visible signs of recovery in response to increased light levels, although still rather closely surrounded by young beech and requiring renewed attention.					

↑ Caption *Keith Alexander*

below the crown level. Different individual trees may respond in different ways, according to their form, vigour and surviving structure.

The need for additional haloing work was also assessed. The time spent on each individual tree varied from 15 to30 minutes, according to the features available. This time allocation was a compromise, based on the need to get around 40 trees in the two days allocated for the study, while at the same time still allowing adequate time for basic investigation and recording.

Oak response

Of the 29 oaks, all except two showed positive responses to haloing, with young epicormic and/or reiterative growth very easy to discern in the lower and mid crown. On one tree, where clearance had been most restricted, the growth appeared to have died early on, possibly as a result of stress caused by oak mildew (Oliver Rackham has suggested that shade tolerance in oak is reduced by mildew). The extent of the response varied considerably, from a little growth to very impressive examples.

Examination of data on the upper crown – which did not form part of the response scores – also reveals some important features. In 23 of the 29 veteran oaks, the upper crown score was the maximum 10, the trees having a well-developed and apparently vigorous extent of live growth, with few, if any, clear gaps. The other six trees were scored lower than 10 for a vareity of reasons. These trees illustrate the value of scoring the tree condition at three levels, as responses at each level vary considerably. Of these six trees, two were thought likely to survive, while a third may do so. In at least three cases, however, the extent of the haloing work is thought to have been insufficient to promote long-term survival, other factors being equal. Additional haloing work may improve the situation.

Sixteen trees formed parts of small groups of oaks which were opened up as a group, rather than singly. While the response was scored from 3 to 10, the average was 6.7 (n=16). In contrast, the single halo trees ranged from 0 to 10 in response, and averaged at 4.5 (n=13). While the data are too few for any statistical analysis, a simple bar chart (Fig. 1) provides a good illustration of the general response level of the two tree groups. The data do suggest that opening up trees as a group rather than singly is more beneficial; light levels will be relatively greater after the haloing in a group.

Beech response

Most of the haloed beech trees showed no obvious

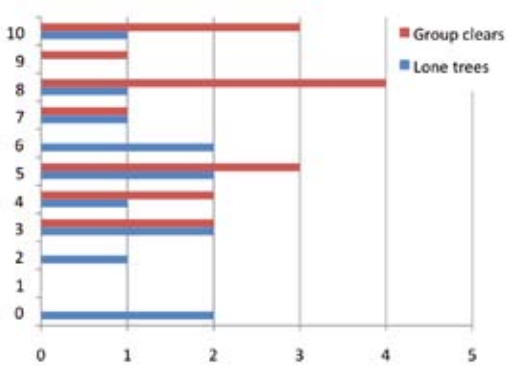
Problems with dramatic release

Early conservation management took the form of complete clearance of the younger trees, but there were many cases where veteran oaks released in this way died within a few years. It was realised that the sudden exposure of a tree that has been shaded for many years can cause problems, for example:

- The etiolated leaves may be vulnerable to sun scorch.
- The tree itself may suffer increased transpiration rates and, with a root system that has been in more of a woodland situation for decades, it becomes more susceptible to drought.
- Desiccation of the bark may stress the tree and cause cracking of hollow trunks, through drying out on the sunny side.

The sudden opening-up of old trees may also be more of a problem where commercial conifer crops are involved because they cast dense year-round shade and create a cooler, moister microclimate.

Figure 1 Bar chart showing response scores in relation to the situation of the treated oak tree.



reiterative or epicormic growth, but many had lower and mid crown live branches which appeared to have remained alive while being overcrowded and shaded within the plantations, i.e. they pre-dated the haloing work. Of the 11 veteran beeches, nine showed extensive such live growth at mid crown and/or lower crown levels, and were therefore assessed as complete successes (scored 10). While the haloing may or may not have been responsible for this extensive growth, it has probably helped such growth to survive.

In three of the nine high-scoring beech trees, the high crown of the veteran trees had collapsed at some stage and fresh vigorous new growth was very apparent from the broken trunk. Two had snapped at about 8m height from the ground, but both had very vigorous reiterative growth from the remaining lateral branches. It seems unlikely that these trees would have responded so successfully under low light levels without haloing. The third tree had lost its upper crown, but a new and vigorous crown had developed at mid trunk level.

Of the two veteran beeches which are thought to have not responded successfully to haloing, one had lost its crown to about 8m height above ground. The lower lateral branches had continued to grow until they had died at some stage the previous winter – the buds appeared intact and healthy, but had not opened in 2009. The most likely explanation for its death appears to be that insufficient branches had survived the collapse to maintain viability for more than a few seasons. The other tree has a fully developed mature canopy, with only limited lateral branching at mid trunk level, and none below. It was impossible to assess whether or not there had been any response to the increased light levels.

↑ Caption *Keith Alexander*

The need for a second phase of haloing

The assessments of the need for follow-up work (further releasing the treated veteran oaks from competing woody growth) are summarised in Table 1. The results very clearly showed a positive relationship between the scale of initial opening-up and the effectiveness of the work.

Table 1 Prioritisation of the need for further release work on veteran oak trees in relation to the size of the first coup

Priority for further release work	Lone veterans	Small groups of veterans	Larger group cleared of competition
High	3	1	
Medium	9	7	
Low		3	
None	1 (dead)		5

Discussion

This preliminary investigation has demonstrated the value of releasing veteran trees from competing woody growth. The trees which failed to respond were generally where the extent of the release work is thought to have been too limited in scope, with canopy competition not cut back far enough. The release of groups of trees appears to have been more successful than the release of single isolated trees. Of course, trees are long-lived organisms and some aspects of the work may not yet be evident; this project is documenting short-term recovery only. There have been concerns that opening up too much at any one time can result in a shock reaction by the tree, and may cause premature death within a year or two of treatment (Read, 2000) – one option to reduce the dramatic change in microclimate around the trunk is to thin the competing trees in an outer circle, and to gradually thin closer in to the trunk. It is very encouraging, however, that these Windsor Forest trees have mostly survived 5 or 6 years on from the treatment, and that only the least-cleared trees appear to have failed. This does suggest that opening up the trees at a larger scale has enabled more trees to survive than might have been the case with a more conservative haloing programme.

The different results for veteran oak and beech

Implications for tree planting

Tree-planting schemes for amenity and conservation tend to comprise comparatively dense planting using forestry techniques, irrespective of whether or not forestry is the objective. If stands of large, old trees, rich in wildlife, are wanted then very wide-spaced plantings are required, and control of any natural regeneration will be needed, unless grazing and browsing is adequate to prevent this from competing with planted stock.

Biodiversity benefits

These are intrinsically very difficult to assess. We focused primarily on the improved potential of the individual veteran tree to continue to live on as a result of the conservation work, and to continue to provide and develop good-quality wood-decay habitats. Evidence was sought for heartwood decay (from signs of activity of bracket fungi) and the presence of cavities suitable for specialist invertebrates, birds and bats. A brief investigation of any accessible rot enabled some recording of specialist invertebrates. Three British Red List click beetles were found, including the European protected species, the violet click beetle.

↑ Caption *Keith Alexander*

are consistent with the known situation of oak being a light-demanding tree, in contrast with the extent of shade-tolerance of beech. Oak is clearly a priority tree for haloing, but retrenching beeches may also be beneficial.

Removing younger, vigorous competing trees may also have great advantages underground for the old tree's mycorrhizal fungi and other supporting micro-organisms when collecting essential minerals, nutrients and trace elements. This aspect has been little investigated and merits further research.

Conservation management implications

Follow-up additional release work is clearly now a priority for some of the veteran trees if the benefits from the first phase of haloing are not now to be lost. The priority for future work was judged to be lower where more was cut initially, suggesting that resources are better invested in larger initial clearance, as less work is then needed in the later phases of the conservation project. No evidence was found for decline or death following the clear-fell, and the only deaths found were of isolated trees which are thought not to have been released sufficiently. Previous haloing work may have been too cautious, as a result of trying to avoid too great a change to the tree's situation and risking shock (see box, page 14). The benefits of opening up these veteran trees may far outweigh the risks. However, more extensive research is needed to investigate reliably the relationships between the distance of clearance of competing growth and any shock reactions.

Haloing work does need follow-up work if carried out on isolated trees within plantations, and preferably within 5-6 years of the initial cutting. In this study, some trees had been lost that might have been saved if they had been re-assessed sooner.

The tree monitoring form arising from this study may prove to be useful on other sites where similar work has been carried out, to document the progress of similar conservation projects. Despite the amount of haloing work being carried out around the country, little evidence of the success of these projects has been published, and that which has been published tends to be anecdotal. While practical knowledge is being developed, the supporting information is being lost and learnt lessons not shared.

Acknowledgement

The authors would like to acknowledge the help of David Lonsdale with our understanding of tree biology.

Further reading and references

A fuller description of this study can be found in the *Quarterly Journal of Forestry* October 2010 104 (4): 257-265.

The key source book for the conservation management of veteran trees is *Veteran Trees: A guide to good management* (English Nature 2000). A companion volume is currently in preparation by the Ancient Tree Forum, which aims to update the EN guide. The *Ancient Tree Guides*, published by the Woodland Trust, provide further information on selected topics. Of particular relevance are:

No 4: What are ancient, veteran and other trees of special interest?

No 7: Trees for the Future.

Read 2000 ???

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