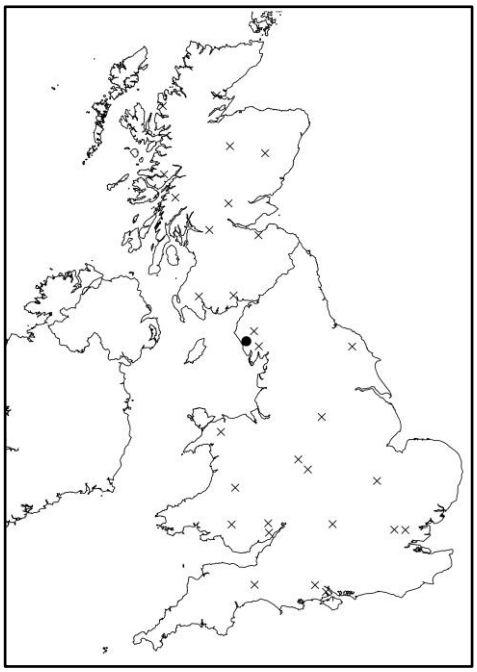
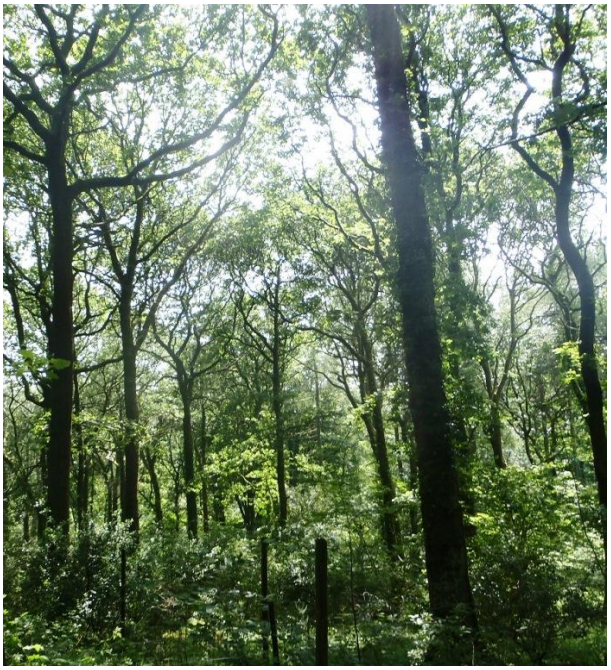
Protecting Oak Ecosystems: Managing oak woodlands to maximize support for oak associated biodiversity.

Case study: Keyhow Coppice, Miterdale



• = current case study site
X = other case study site



High forest structure at Miterdale, with oak-dominated overstorey and developing understorey of other broadleaved species.

Case Study key facts

Location: Cumbria, England

Landscape context: On a gently sloping south-facing hillside, with grazed farmland surrounding it. The northern part of the woodland is coniferous, with the lower, southern part being the oak woodland.

Case study area: 1.2 ha oak wood, in a wider woodland setting of 4.2 ha

Proportion of oak in stand canopy: 100%

Woodland type: High forest

NVC Woodland type: W11 (*Quercus petraea-Betula pubescens-Oxalis acetosella* woodland; sessile oak – downy birch – wood sorrel woodland)

Vulnerable oak-associated species: 5 obligate species, 5 highly associated species.

Likely scenario: No changes in oak suitability are expected on this site. But in this region extreme climatic shifts to wetter winters and drier summers events will be more frequent, resulting in increased future stress to oak woodlands, particularly on surface-water gley soils (crown density reduction, die-back, bleeding lesions).

Site Characteristics

Woodland type: High forest; likely to be an ancient semi-natural oak woodland

Soil type: Brown earth

Stand structure: High forest with an overstorey cover of almost 100% and very little permanent or temporary open habitat. The canopy is dominated by mature oak trees, over 20 m tall and over 30 cm DBH. A developing understorey of young trees is present. Holly is present throughout the woodland, at c. 30% cover, with seedlings, saplings and young trees present. Sycamore, rowan and hazel seedlings, saplings and young trees are present but occasional and patchy throughout the woodland, with c. 10% cover each. There are occasional young seedlings of oak at c. 5% cover, distributed patchily though the woodland, but no oak saplings or young trees are present.

Ground vegetation: The ground cover is dominated by bracken and ferns, at c. 50%, with bluebells, wood sorrel, bramble, grasses and honeysuckle also present.

Current management: The woodland is currently managed under a continuous cover forestry system through a combination of group felling and thinning to favour native woodland regeneration.

Woodland Biodiversity

Designations: This may be an ancient semi-natural woodland, however it is not designated.

Oak associated species: There are 381 oak-associated species that have been recorded in the area. Of these species 5 are obligate (only known to occur on oak trees), these are all beetles. A further 5 highly associated species were identified (3 invertebrates and 2 lichens), these are species that are predominately found only on oak trees but will occasionally occur on other tree species. Species that use oak more frequently than its availability in the landscape but use a wider range of trees than the highly associated species are termed partially associated species. There are 48 partially associated oak species recorded in the area: 10 birds, 14 invertebrates, 22 lichens and 2 mammal species. Of the 381 oak-associated species 158 species use the dead wood associated with oak trees, this includes 1 bird species, 56 bryophytes, 14 invertebrates, 87 lichens species. These species may increase in abundance if there is an increase in dead wood associated with oak.

Management Plan for maximising oak associated biodiversity

Long-term vision: An oak-dominated woodland with a diverse structure and an element of other native broadleaved species. A small element of non-native broadleaved species will be welcomed if their presence is beneficial to the oak-associated biodiversity present.

Management objectives: To provide a range of habitats to support the oak-associated biodiversity in the woodland and ensure long-term presence of oak-dominated woodland.

Target species composition and stand structure: The overstorey should remain oak-dominated but a small element of native and non-native tree species will be allowed to increase the diversity of the stand and increase the range of habitats provided. Although sycamore is non-native, it is already present on the site in small quantities and can support many oak associated species present (see Annex A). The dominance of holly in the understorey should be reduced as this is highly competitive with young tree seedlings and saplings and limits their development.

Natural regeneration of sycamore, rowan and hazel in the understorey is already present and should be encouraged. However, although oak seedlings are present there are no successful oak saplings or young trees, probably due to a combination of deer browsing and low light levels. Oak regeneration will be favoured in the future and the contribution of oak to the understorey will increase, with some trees eventually replacing ageing overstorey trees.

Regeneration methods: The overstorey is very dense with very little open habitat. Crown thinning of some of the overstorey trees would increase light levels in the understorey and create canopy gaps to be occupied by developing understorey trees or natural regeneration. Use of natural regeneration would capitalise on the existing site adaptation of the parent trees and ensure that the next generation are well adapted to the conditions. Natural regeneration occurring in canopy gaps should be promoted, by controlling ground vegetation where required, and by protecting seedlings and saplings from deer browsing.

Monitoring: Changes in the species composition and stand structure should be monitored to ensure that the interventions made result in the desired outcomes. The contribution of sycamore should be recorded and steps taken if its dominance starts to increase beyond the agreed target. The success and changing species composition of natural regeneration should also be monitored to ensure that oak saplings and young trees are developing and will eventually contribute to the overstorey.

Operational factors: The woodland is not currently fenced against deer, and deer browsing is present, including damage to natural regeneration. The lack of oak saplings suggests that regeneration may be limited by deer browsing pressure. It is important to exclude deer from the woodland, or to provide some alternative form of protection from deer browsing in order to establish the next generation of oak trees in the woodland.

Relatively dense bracken and fern cover in the woodland is also likely to inhibit natural regeneration and compete with regenerating trees. As ground vegetation is likely to become denser and more vigorous following thinning of the overstorey, control of

competing vegetation where natural regeneration occurs may be required to establish young trees.

Deadwood should be left in the woodland to support the large number of oak associated and other species that use it.

There are no protected species recorded for this site, although the oak associated biodiversity in the area is high. Care should be taken to ensure that interventions do not impact negatively on the species present.

The proposed management option to maximize persistence of oak-associated species requires acceptance of sycamore (which is not considered native in this area) on the ASNW site. This should be carefully considered and the potential positive and negative impacts of a small element of sycamore on the oak associated biodiversity should be reviewed.

The management recommendations set out in this case study scenario do not constitute consent for any operations, which would be required from the relevant body.

Annex A: Identification of additional tree species which are beneficial to oak-associated biodiversity

In the event of a significant loss of oak (not currently predicted for any of oak diseases present in the UK) it may be desirable to encourage a greater diversity of other beneficial tree species to support oak-associated biodiversity. If oak abundance were to significantly decline due to either climate change or disease it would be those species that are most reliant on oak, (obligate, highly associated and partially associated species) that would be at risk of declining in abundance. No other tree species will support obligate oak-associated species, therefore the analysis concentrated on identifying the tree species that would support the greatest number of highly and partially associated species present at the site using OakEcol[1]. Those tree species assessed as supporting a high percentage of the oak-associated biodiversity present at the site and that are able to establish and grow at the site based on soil and climatic factors[2] were selected. The mixture of tree species identified were selected by prioritizing the tree species supporting the greatest number of highly-associated oak-species and partially associated oak-species[3].

Table 1. Number and cumulative number of oak associated species known to be supported by the most suitable beneficial tree species and mixtures of tree species. Number of species are based on records showing a total of 381 oak-associated species at Mitterdale, which include 5 highly associated and 48 partially associated species.

	Number of oak-associated species supported at the site.			Cumulative number (and percentage) of species supported by the addition of each new tree species (from the top of the list downwards).		
	Highly associated	Partially associated	All	Highly associated	Partially associated	All
Sycamore	0	20	92	0 (0%)	20 (42%)	92 (24%)
Alder	1	18	84	1 (20%)	31 (65%)	145 (38%)
Beech	1	19	84	1 (20%)	37 (77%)	171 (45%)
Sweet chestnut	1	9	25	2 (40%)	37 (77%)	172 (45%)

Summary: Additional beneficial tree species.
Most of the highly associated species known to be present in the area are not known to be supported by any of the tree species studied. One species (*Usnea ceratina* a lichen) is supported by 3 different tree species (alder, beech and ash) and a second highly associated species (*Scolytus intricatus* oak bark beetle), is supported by sweet chestnut. Given the very limited data available on the use made of other tree species by the highly associated oak species the analysis considered the support provided to partially associated species as a starting point to select beneficial tree species.

[1] The OakEcol database is available at: https://www.hutton.ac.uk/oak-decline
[2] Site suitability (climate and soils) for different tree species was based on: Pyatt DG, Ray D, Fletcher J. 2001. An ecological site classification for forestry in Great Britain: bulletin 124. Edinburgh: Forestry Commission
[3] See accompanying methodological documentation: Mitchell et al Managing oak woodlands to maximize support for oak associated biodiversity: 30 cases studies. https://www.hutton.ac.uk/oak-decline

Based on the analysis above sycamore, alder and beech (which would all grow at the site) would support 1 out of the 5 highly associated species and 37 out of 48 partially associated species known to occur at the site. Thus, these three tree species would support over three-quarters the partially associated oak species but very few of the highly associated species. Encouraging sweet chestnut to establish would provide support for one additional highly associated species but not increase the number of other oak associated species supported. Thus the decision on whether to include this tree species in the mix will depend on the level of priority associated with the oak bark beetle (*Scolytus intricatus*). Sycamore, alder, beech and sweet chestnut will need to be grown in different areas or within compatible mixtures within the wood to match site micro-climate conditions and species light requirements. Some of these beneficial tree species are already present at the site (see above) and their abundance could be increased but others are not. Sycamore is a non-native tree species and currently planting non-native tree species in existing native woodland is not recommended, although sycamore is generally tolerated where it is already present.
This study has concentrated on identification of other tree species that would support oak-associated biodiversity. However, some shrubs, e.g. hazel, that are not included in this study may also support oak-associated species.

While we have concentrated on identifying trees to support oak-associated biodiversity it should be noted that a change in tree canopy composition due to loss of oak and increased abundance of these beneficial tree species, will drive changes in ground flora composition (due to changes in shading) and in ecosystem functioning such as litter decomposition, soil chemistry and carbon storage (Table 2). When deciding which beneficial tree species to encourage a trade-off may have to be made between supporting oak-associated species and changes in these other woodland functions.

Table 2. Likely impact on selected ecosystem functions and shading of ground flora of selected beneficial tree species compared to oak.

	Functioning*	Shade**
Field Maple	Data lacking	Lighter shade
Sycamore	Faster litter decomposition. Litter and soil have a higher nitrogen concentration and lower carbon concentration	Similar
Alder	Faster litter decomposition. Litter and soil have a higher nitrogen concentration and lower carbon concentration	Lighter shade
Sweet Chestnut	Similar to oak but with slightly slower litter decomposition. Litter and soil have a slightly higher carbon concentration and slightly lower nitrogen concentration	Similar
Beech	Similar to oak but with slightly slower litter decomposition. Litter and soil have a slightly higher carbon concentration and slightly lower nitrogen concentration	Darker shade

*Functioning information based on extensive literature reviews of comparative data and analysed in Mitchell et al (submitted) Collapsing foundations: the ecology of the British oak,

implications of its decline and mitigation options. Biological Conservation on line early DOI 10.1016/j.biocon.2019.03.040.

**Shading information based on expert judgement. The above provides a broad comparison of individual tree species compared to oak; the overall shade cast will depend on the mix of species in the canopy, the age of the trees and the density of trees. If the shade cast by the tree species is lighter than oak then light demanding ground flora species may increase in abundance. If the shade cast by the tree is darker than oak then light demanding ground flora species may decrease in abundance.

Acknowledgements: The work was funded by Defra through the BBSRC grant Protecting Oak Ecosystems (PuRpOsE): BB/N022831/1. With additional support from the Forestry Commission England and the Scottish Government's Rural and Environment Research and Analysis Directorate 2016-2021 strategic research programme. We thank Duncan Ray and Andrew Rattey for help with the predictions of changes in oak condition over time and the Forest Research Technical Support team for their help with the fieldwork. Finally we thank the site owners for access to their land.

Citation: Mitchell R.J., Broome A, Hewison RL, Stokes V. (2019) Protecting Oak Ecosystems: Managing oak woodlands to maximize support for oak associated biodiversity. Case study: Miterdale. Available at https://www.hutton.ac.uk/oak-decline