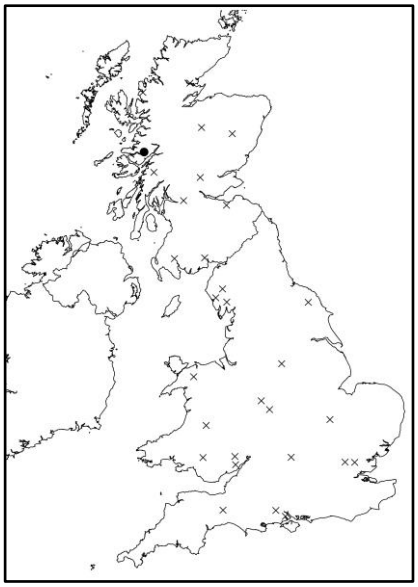
Protecting Oak Ecosystems: Managing oak woodlands to maximize support for oak associated biodiversity.

Case study: Ariundle



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

Oak dominated overstorey of mature and veteran trees at Ariundle

Case Study key facts

Location: Highland, Scotland

Landscape context: A large woodland on steeply sloping, south-east facing slopes on the northern side of Strontian Glen. Part of a larger area of woodland up the valley bordered by open hill and mountains to the north, deciduous woodland to the west and coniferous woodland to the east.

Case study area: c. 2.0 ha in a wider woodland area of 70 ha

Proportion of oak in stand canopy: 90%

Woodland type: Predominantly high forest, some areas are coppice with standards and there is evidence of old coppicing.

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

Vulnerable oak-associated species: 2 obligate species, 4 highly associated species.

Likely scenario: No changes in oak suitability are expected on this site, but extreme events are likely to become more frequent, resulting in increased stress in the coming decades

Site Characteristics

Woodland type: Mostly high forest; an ancient semi-natural oak woodland.

Soil type: Molinia bogs and surface water gleys

Stand structure: The overstorey in the case study area is dominated by oak (c. 90%) with both mature and veteran trees present. Sessile and pendunculate oaks are present, together with their hybrids. Some have exceptionally large girths and heavy epiphyte growth. Birch is also present in the overstorey (c. 5%) and hazel, rowan and willow are also present (c. 1% each). There is no permanent open habitat and only c. 2% temporary open habitat. Both new and established seedlings of oak are common throughout the woodland, but these have not developed into saplings or young trees. Holly and birch saplings are present in low numbers, and seedlings of rowan and hazel, and more rarely ash are present.

Ground vegetation: The ground vegetation is dominated by mosses, grasses, bilberry and bracken.

Current management: Ariundle is a NNR and SSSI managed for biodiversity. The woodland is a surviving fragment of an ancient oak woodland and part of the Atlantic rainforest, which is climatically limited to the western edge of Europe, and reaches its best development in the west of Scotland. During the late 18th to late 19th centuries the oak trees at Ariundle were coppiced as a source of charcoal for fuel which was used in relation to the Strontian lead mines. Historical records suggest a twenty year rotation for coppicing was followed. Intensity of management reduced from the late 19th century when the woodland was used primarily to shelter domestic stock. Planting of oak and other non-native trees such as larch, beech and Norway spruce has also occurred. The woodland became a nature reserve in 1961. In the late 1970s, a large fence was erected around the woodland and all deer and domestic stock were removed; an on-going deer cull within the fenced area continues to present.

Specific to improving the woodland condition, management focuses on removal and control of rhododendron, expansion of new native woodland (by natural regeneration or planting) around the existing woodland, improving the structure of the woodland by increasing the proportion of saplings and mature trees present for all native species, increasing the quantities of dead wood which is present, and retaining open glades. Deer are managed to support these aims.

As a result of current management policy, it is hoped that over time the woodland will become more diverse and representative of natural oak woodland, with a significant proportion of saplings and mature trees present for all native species.

Woodland Biodiversity

Designations: The woodland is composed of two types of Habitats Directive Annex 1 habitats. Old sessile oak woods with holly and *Blechnum* ferns in the British Isles and Mixed broadleaved woodland of slopes, screes and ravines, although at Ariundle, the characteristic tree species of the latter type (lime and maple) are absent. One of the richest habitats in

Europe for mosses, liverworts and lichens, the bryophyte flora includes one nationally rare species of moss *Dicranodontium denudatum*, one nationally scarce species of moss *Sematophyllum micans*, and several nationally scarce species of liverwort. Ferns such as hay scented buckler fern and Tunbridge filmy fern, are well represented within the woodlands, and one stage of the life cycle (gametophyte) of the Killarney fern is also known to be present. Also present at Ariundle are three European Protected Species (EPS; otter, pipistrelle bat and wildcat), six further species which are protected (pine marten, Scottish crossbill, chequered skipper, pearl-bordered fritillary, small-pearl bordered fritillary and the lichen Norwegian specklebelly) and a red data book invertebrate (northern emerald dragonfly).

Oak associated species: There are 253 oak-associated species that have been recorded in the area. Of these species two are obligate (only known to occur on oak trees): a gall wasp and a moth. A further 4 highly associated species were identified (1 moth and 3 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 59 partially associated oak species recorded in the area: 5 birds, 23 invertebrates, 30 lichens and 1 mammal. Of the 253 oak-associated species 102 species use the dead wood associated with oak trees, this includes 2 bird species, 80 bryophytes (mosses and liverworts), and 20 lichen 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: A thriving and resilient oak-dominated woodland with range of age classes and a small proportion of other native broadleaved species present.

Management objectives: The key management objective is to guarantee security of the habitats utilised by the rare and protected species by ensuring continuity of oak-dominated woodland on the site.

Target species composition and stand structure: The future stand composition will remain oak-dominated with up to 20% of the stand comprising of other native broadleaved species which are already present; birch, rowan, hazel, willow, holly, wych elm. Ash is also currently present, but this species may decline in abundance due to ash dieback. Alder (which is currently present in the wider woodland area but not in the case study site) would help to support some of the highly and partially associated species, and so introduction into the wetter areas in this part of the woodland may be beneficial (see Annex A). The target structure will have all tree sizes and ages present, from young regenerating seedlings to mature and veteran trees.

Regeneration methods: As use of natural regeneration takes advantage of site adaptation this will be the favoured method of regeneration on the site, ensuring that future generations of trees are well adapted to the site and climatic conditions. As saplings of equally or more palatable species than oak are present (holly, rowan, ash) this suggests that browsing may not be the only factor limiting regeneration and a small amount of overstorey

thinning may be beneficial to reduce competition between overstorey trees and to allow sufficient light penetration for successful seedling establishment. Introduction of alder could be achieved either by planting, or by direct sowing; in either case the trees or seeds should be from local sources, suited to the site and environmental conditions.

Monitoring: Although there are currently no known tree health problems at Ariundle, it is important to carry out a regular monitoring programme so that if any problems arise managers can act quickly. Monitoring should also include details of stand structure and species composition, to ensure that any changes are within the targets defined. This will also alert managers if any non-native species start to colonise the woodland. The incidence and success of natural regeneration, and the impacts of deer browsing on this should be quantified and monitored frequently so that steps can be taken if this worsens.

Operational factors: The ground vegetation, which is dominated by mosses, is unlikely to severely restrict natural regeneration, but in some areas where coarse grasses are more dominant this may be a problem. Shallow screefing or scraping of the surface vegetation in these areas may facilitate seedling germination and survival by reducing competition during the early establishment phase. If thinning is carried out bracken may become more dominant in the increased light levels and this may need controlling to prevent competition with regenerating seedlings.

There is some limited road access into the woodland but not to all areas. In the past extraction of non-native species has been carried out by horses to avoid compaction, and this may be advisable for any future operations. If non-native tree species are found to be present in the woodland in the future, similar operations should be carried out to remove them and maintain the site as native species woodland.

Although at least part of the NNR is deer fenced, evidence of deer browsing was seen on the site, and this is likely to be having a negative impact on regeneration success. Removal of deer from inside the fenced area, and ensuring that the fence is secure would increase the chances of success for regenerating seedlings and saplings.

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

There are a large number of protected species at Ariundle (described above) and it is important that any operations are carefully planned and compatible with the species present, to ensure that habitats are maintained and none of the species is adversely impacted.

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 253 oak-associated species at Ariundle, which include 4 highly associated and 59 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
Rowan	2	8	50	2 (50%)	8 (14%)	50 (20%)
Alder	1	26	74	2 (50%)	30 (51%)	105 (42%)
Downy birch	0	11	41	2 (50%)	38 (64%)	123 (49%)
Sycamore	0	15	55	2 (50%)	44 75(%)	145 (57%)

Summary: Additional potentially beneficial tree species.
Based on the analysis above rowan and alder (which would both grow at the site) would support 2 out of the 4 highly associated species and 30 out of 59 partially associated species known to occur at the site. The other two highly associated species are supported by ash, which is threatened by ash dieback and Turkey oak which would not grow at the site. If a more diverse woodland was established including downy birch and sycamore then 75% of the partially associated species would be supported but this would not increase the number of highly associated species supported. These tree species may need to be grown in different areas or within compatible mixtures within the wood to match site micro-climate

[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

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**
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
Birch (Silver and downy)	Faster litter decomposition. Litter and soil have a higher nitrogen concentration and lower carbon concentration	Lighter shade
Rowan	Data lacking	Lighter 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.

**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: Ariundle. Available at https://www.hutton.ac.uk/oak-decline