Fuller, R. & Calladine, J. 2014.
BOU Proceedings – Ecology and conservation of birds in upland and alpine habitats
http://www.bou.org.uk/bouproc-net/uplands/fuller&calladine.pdf

Proceedings of the BOU's 2014 Annual Conference
Ecology and conservation of birds in upland and alpine habitats
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Landscape transition through natural processes: implications for biodiversity of tree regeneration on moorland

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In the absence of sustained heavy grazing by large herbivores or large-scale burning, many mountain areas in Britain would naturally have higher levels of tree cover, with extensive zones of treeline scrub. Reduced grazing pressure has transformed landscapes in several mountainous regions of Europe in the 20th century. For example, forest has rapidly developed over large tracts of Mediterranean land as traditional grazing has collapsed, causing declines in open country and early successional species (Sirami *et al*. 2008). In Britain, especially in Scotland, there has been localized expansion of scrub as pressure from deer and sheep has eased in some areas. There has also been increased planting of native trees. These recent changes in tree cover (in response to land use and conservation initiatives) give some insights into the types of bird assemblages that could potentially develop in the British uplands if large-scale changes occurred in land management. The relative importance of wild deer, domestic herbivores and burning in suppressing scrub differs across the British uplands and their limitation would be a prerequisite for extensive scrub development.

Trees, scrub and woodland form critical ecological components of mountain and moorland environments for approximately 20 bird species associated with the British uplands. Several studies undertaken over the last 20 years in the Scottish Highlands and in Wales document how upland bird assemblages are influenced by the extent of scrub or woodland, and how these assemblages change with successional stage (Fuller *et al*. 1999, 2006; Gillings *et al*. 1998, 2000; Calladine & Bray 2012; Conway & Fuller 2012). Growth rates of trees and changes in bird assemblages under natural regeneration are generally slow on the nutrient-poor soils and harsh climates prevailing over most of the British uplands. Especially in Scotland, where naturally regenerating scrub tends to be strongly dominated by birch *Betula* spp. and Scots Pine *Pinus sylvestris*, vegetation structures are relatively simple compared with more diverse and dynamic forms of scrub occurring in lowlands with more mineral-rich soils. Avian species richness in much upland scrub tends to be lower and, at least in the eastern Scottish Highlands, there appears to be more overlap between scrub and mature woodland in the characteristic bird species than would be expected in the southern British lowlands. The niche breadth of species in Highland scrub, with respect to successional stage, can be large. For example, on Deeside, Tree Pipit *Anthus trivialis* and Willow Warbler *Phylloscopus trochilus* can occur across all growth stages from open canopy scrub to old birch woodland, whereas in the lowlands they are more typically confined to the early stages. Nonetheless, a few scrub specialists can be identified in the

uplands, e.g. Black Grouse *Tetrao tetrix.* On Deeside, the number of territory-holding bird species in old birch woodland is nearly four times higher than that on moorland, with open and closed scrub having intermediate levels of richness.

Surveys of breeding birds and vegetation have been conducted over 16 years since the mid 1990s at four sites with naturally regenerating pine and birch in the Scottish Highlands. These show that changes in bird assemblages are slow, at least from the time of scrub establishment (our unpublished data). The numbers of bird species have gradually increased over this period and change in the total abundance of birds is positively related to change in tree cover. There has been a pattern of increasing dominance by Willow Warblers from approximately 15 to 25% of all birds counted. A comparison of bird assemblages in naturally regenerated scrub with those in young native plantations in the Scottish Highlands indicates interesting differences (our unpublished data). Species number and overall abundance of birds is higher in the plantations but dominance by Willow Warblers is lower. These differences may be related to the higher diversity of tree species generally found in young plantations but they may also be linked to differences in vegetation structure. Some species of conservation interest appear to prefer natural regeneration: Black Grouse, Tree Pipit and Eurasian Bullfinch *Pyrrhula pyrrhula*.

In the Welsh mountains, the marginal slopes frequently support mosaics of woodland, scrub, Common Bracken *Pteridium aquilinum*, grass and Heather *Calluna vulgaris*. Not surprisingly, the composition of the bird communities in these areas is strongly determined by the mixture of vegetation types present. The cover of woodland and bracken are positively associated with the abundance of a high proportion of the bird species present in these environments. Gorse *Ulex* spp. scrub is also important to several bird species. However, the apparent habitat associations of individual species with particular vegetation types are affected by the scale on which these are examined. For example, associations with vegetation cover can differ at the scale of the territory or the location of an individual bird (Conway & Fuller 2012).

Widespread natural regeneration of scrub, and ultimately the development of tracts of 'natural' forest, could result in substantially richer biological communities in certain parts of the British uplands. This is illustrated well by an assessment of habitat dependencies of a range of taxa for which the Cairngorms, Scottish Highlands, are regarded as nationally or internationally important (Shaw & Thompson 2006). A total of 1153 species was examined (of which 80% were invertebrates, lichens or fungi and 2% were birds). Woodland was the primary habitat for 39% of these species although it covered just 17% of the land area; moorland was the primary habitat of 3% of species but covered 42% of the land. Although the British moorland bird assemblage is considered of international importance (Thompson *et al.* 1995), there are substantial tracts of land which carry extremely low densities of moorland birds. In such areas, an increase in biological diversity would seem to be an

argument in favour of woodland expansion. Whether bird assemblages could ever develop in Britain similar to those occurring in the vast tracts of Scandinavian alpine scrub is questionable, given the lower diversity of topography and the insularity and relatively small scale of the British uplands.

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