Forestry Commission

Research Note

The implications of upland conifer management for breeding birds

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Stand structure is an important determinant of habitat quality for forest biodiversity and is influenced by management. In conifer plantations, the varied structure created within a stand by continuous cover forestry (CCF) systems has been expected to be better for woodland birds than the range of discrete stand structures created through rotations of clearfelling and replanting (CFR). This study compared the number of breeding bird species (species richness) and their abundance within Sitka spruce stands which have been managed under CCF and by CFR. The study showed that species richness within CCF stands was higher than in CFR but young growth stages of CFR were important for some birds. Bird species richness is further influenced by the presence of a woody understorey or scrub vegetation structure. When stand types were ranked by species richness alone, CCF with a shrubby understorey was the most species rich, followed by CCF without a shrubby understorey, with young CFR and then older CFR being the least species rich. Modelling scenarios were used to test the effect of changing proportions of CCF and CFR in the landscape on the abundance of selected species. Designing a landscape which includes both CFR and CCF could prove to be a strategy for achieving optimal bird richness and abundance, as conditions for scrub-dependent species and the high structural diversity important for bird species associated with older stands are maintained.

Introduction

Most British conifer plantations are managed by clearfelling and replanting (CFR) through which coupes are managed on a 30–60 year rotation. This results in forests comprising adjacent but discrete stands of different but uniform aged trees. However, there has been a shift in policy to encourage conversion to continuous cover forestry (CCF) systems that include selective felling of single trees to small coupes of up to about 0.25 ha but which maintain forest cover more uniformly across stands. Where seed sources and browsing pressure permit, trees can naturally regenerate in cleared areas, or otherwise are introduced by supplementary planting. The two contrasting silvicultural systems establish and maintain a diversity of tree ages, and therefore structures, but the structural diversity is at a much finer scale in CCF than with CFR and there can be a greater opportunity for some trees to grow older under CCF (Figure 1). An important difference between CCF and CFR is the distribution of young trees. Areas of shrubs or young trees are important habitats for birds (Fuller, 2012). Within CFR, young trees (at the thicket and pre-thicket stage) are structurally equivalent to scrub or shrubland and occur as discrete and often extensive blocks. Within CCF, young trees occur as a woody understorey and their density may depend on the thinning intensity of the canopy trees and browsing pressure.

The responses of birds to CFR in conifer plantations are relatively well understood but the implications of applying alternative stand management systems (e.g. CCF) are less so. In Europe, there is limited evidence of the benefits for forest birds (du Bus de Warnaffe and Deconchat, 2008), and the potential impacts on birds reliant on early successional growth stages are, arguably, not well considered. Although conversion of plantations by changing management from CFR to CCF might be expected to deliver more bird species that are typically found in more mature forests (and for some of those species to be more abundant), there is a possible consequence that the birds associated with extensive scrub or shrubland could diminish. This is an important consideration because Britain has relatively few forest specialist species but many species which are thought to prefer wooded and shrub areas. Trends in breeding bird population sizes are used as one of the key indicators of the state of the UK's biodiversity and the ongoing declines recorded since 1970 are therefore of concern.

Study aims

The aims of the study were to assess if:

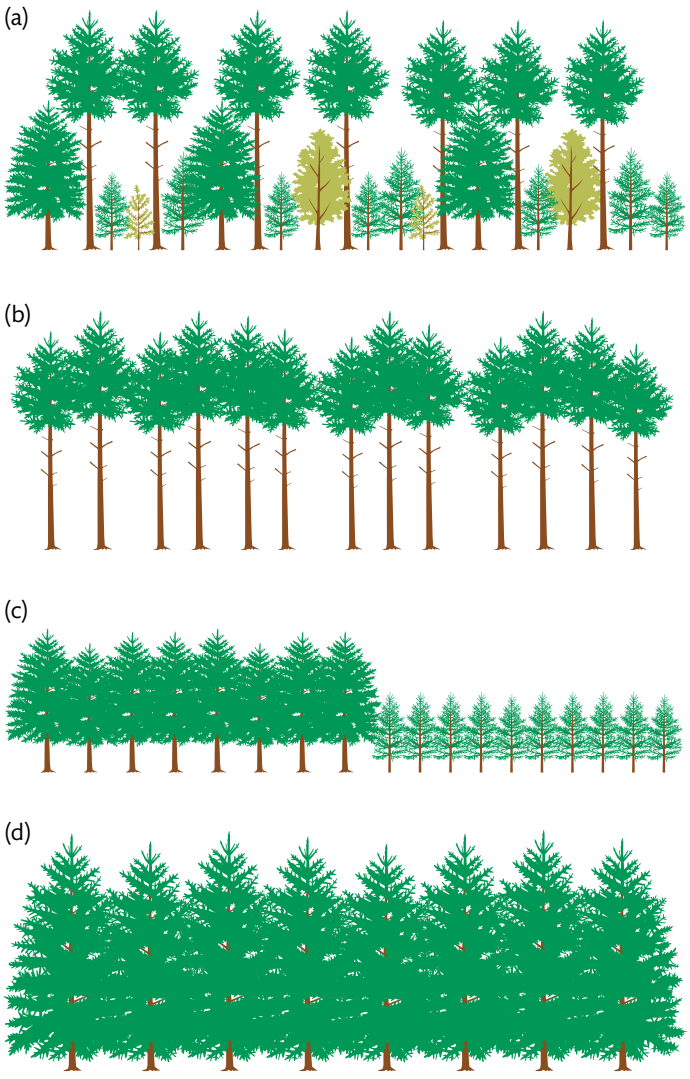
1. CCF can support more birds typical of mature forests ('forest birds') relative to CFR-managed plantations (including the more mature stands within CFR).
2. CFR can support a broader range of open habitat and scrub specialist bird species relative to CCF-managed plantations (including those with a developed regenerating understorey).

Methods

Study areas

Four suitable Sitka spruce dominated study areas were located, three in Scotland (sites in Perthshire, Argyll and the Borders) and one in northeast Wales. Potential study areas were limited as the CCF study sites needed to be sufficiently developed for their structure to differ from that of maturing CFR. Plantations under transformation to be managed as CCF but where trees were still of uniform age and less than 30 years old were not suitable as

Figure 1 A schematic diagram of the four management categories: (a) continuous cover forestry with a regenerating understorey; (b) continuous cover forestry without a regenerating understorey; (c) young growth stage clearfell and replanted forestry; (d) older growth stage clearfell and replanted forestry.



they were structurally identical to CFR plots of a similar age. Sites also needed to be large enough (>5 ha) to be able to support a bird community with the potential to differ from that of surrounding CFR plantations. Each CCF study area was paired with a similarly sized CFR site of comparable altitude, aspect and underlying geology and within 15 km distance. All study areas were second rotation plantings.

Timed point counts were used to survey breeding birds with points at intersections of a 150 m grid to permit representative sampling while also ensuring independence of data collected at each point (Figure 2). Four contrasting stand types were sampled by the surveys (Figure 1):

(a) **CCF shrub understorey** – CCF with a regenerating understorey of young growth trees, effectively creating a shrub layer underneath the main forest canopy (60 sampling points).
(b) **CCF no shrubs** – CCF without a regenerating understorey or where it was very restricted and patchy (104 sampling points).
(c) **CFR thicket stage** – Young growth CFR (trees 10 years old or less) with thicket and pre-thicket growth stages which effectively create an extensive area of scrub or shrubland (59 sampling points).
(d) **CFR post-thicket stage** – Older CFR with closed canopy stands with trees 15–40 years old (112 sampling points).

Figure 2 Sampling on a 150 m grid at the Scottish Borders study area from which timed point counts of birds were undertaken. Distance bands from the central sample point (red dot) of 25 m (small black circle), 50 m (large black circle) and 150 m (large grey circle) are indicated on the figure.

Bird surveys and analyses

The survey was carried out during the 2012 breeding season. Timed counts (10 minutes) were used to sample bird abundance at each survey point, with two counts at each point ('early counts' in April or May and 'late counts' in June). All birds seen or heard were attributed to one of four distance bands where first detected from the count point (25 m; 25–50 m; 50–100 m; and >100 m). Statistical models (generalised linear mixed models (GLMMs)) were used to assess differences in bird species richness and abundance between the four stand types. To permit direct comparison between stand types, birds recorded more than 50 m from the sampling points were excluded from the abundance analyses.

A simulation for conversion to CCF

To examine the likely influences on breeding birds of converting plantations from CFR to CCF management, a hypothetical forest, 50 km^2 in area was considered, in which 0–100% (in 20% increments) was managed as CCF and the remainder as CFR. The simulation assumed that, at any one time, one-third of any CCF would support a regenerating understorey and one-third of any CFR would be of pre-thicket and thicket growth stages. The densities of four example species found within each of the four stand types were extrapolated to illustrate some likely influences on the populations of those species within the 50 km^2 area. Example species (willow warbler, blackcap, great tit and lesser redpoll) were selected because: (a) they showed contrasting associations with the four stand types (Table 1) and (b) because they were sufficiently numerous within the sampled study areas for data to be considered representative.

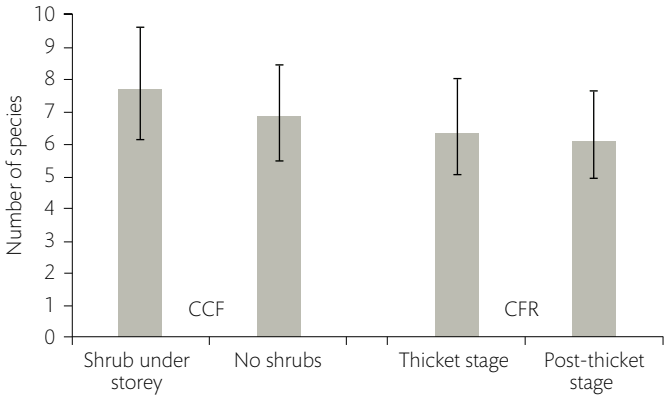
Results

Plantation stand structure and birds

There was a modest but statistically significant difference in the number of species recorded between the four stand types (Figure 3). CCF with a shrubby understorey was the most species rich, followed by CCF without a shrubby understorey, then young CFR and then older CFR. Overall, 57 species were recorded in CCF stands, 48 in CFR and 42 in both.

Among the species sufficiently numerous for successful convergence of the statistical models, a number of interesting relationships were apparent that showed a likely influence of both shrub (young tree) distribution within a plantation and also of different canopy structures (Tables 1 and 2).

Figure 3 Bird species richness in the four stand structures. The mean number (and standard error) of species recorded from sampling points in each category are shown.



The means and standard errors are estimated by back-transformation of the least square means (and their confidence intervals) of the GLMMs that modelled species richness (the dependent variable) with stand type as a fixed factor and study area as a random variable. Statistically significant differences were: CCF with shrubs > CFR of both stand types ($P < 0.001$); CCF with no shrubs > CFR post-thicket stage ($P = 0.04$). Marginally non-significant differences were: CCF with shrubs > CCF with no shrubs ($P = 0.05$); CCF with no shrubs > CFR thicket and pre-thicket ($P = 0.06$).

In the more mature stands, great spotted woodpecker, blackcap, garden warbler and willow warbler were more abundant in areas with an understorey of young trees (all within CCF-managed areas). Also within mature stands, some other species (wood pigeon, wren, goldcrest, blue tit, great tit, lesser redpoll and common crossbill) were also more abundant in CCF than in CFR but with no apparent association with the presence of an understorey, which suggests a possible influence of different canopy structures. Only two species (dunnock and treecreeper) were less abundant in stands of CCF than in mature CFR.

The majority of species were more abundant in CCF stands with a regenerating understorey than in young CFR. This is perhaps expected as this group of birds includes many which are essentially forest rather than shrubland species. There were, however, three species (dunnock, willow warbler and lesser redpoll) which were more abundant in young CFR than in CCF with an understorey.

These associations will reflect some of the underlying ecology of the birds. For example, species which were found more

Table 1 Plantation features that were associated with higher numbers of bird species (species richness) and abundance of individual species (indicated by a tick). These associations are derived from *post hoc* pairwise comparisons following statistical models (GLMMs) assessing species richness and abundance within the four stand structures. The summary is restricted to the most numerous species, where statistical models could be employed, and identifies statistically significant pairwise comparisons between stand structure types.

Stand types[1] relevant to plantation feature ordered by bird richness/abundance	Older tree attributes:		Young trees as:	
	Enhanced by CCF a > d, b > d	Regardless of management b > c, d > c	Understorey (CCF) a > b	Discrete stands (CFR) c > a
Species richness	✓		✓	
Species				
Wood pigeon *Columba palumbus*	✓			
Great spotted woodpecker *Dendrocopos major*	✓		✓	
Wren *Troglodytes troglodytes*	✓			
Dunnock *Prunella modularis* [2]				✓
Blackcap *Sylvia atricapilla*	✓		✓	
Garden warbler *Sylvia borin*	✓		✓	
Willow warbler *Phylloscopus trochilus*	✓			✓
Goldcrest *Regulus regulus* [3]	✓			
Blue tit *Cyanistes caeruleus*	✓			
Great tit *Parus major*	✓			
Coal tit *Periparus ater*		✓		
Treecreeper *Certhia familiaris* [2]				
Siskin *Carduelis spinus*		✓		
Lesser redpoll *Carduelis cabaret*	✓			✓
Chaffinch *Fringilla coelebs*		✓		
Common crossbill *Loxia curvirostra* [4]	✓			

[1] a = CCF with a regenerating understorey of young growth trees, effectively creating a shrub layer underneath the main forest canopy; b = CCF without a regenerating understorey or where it was very restricted and patchy; c = Young growth CFR – thicket and pre-thicket growth stages which effectively create an extensive area of scrub or shrubland; d = Older CFR – closed canopy stands with trees 15–40 years old. [2] Treecreeper and dunnock were more abundant in older CFR than in CCF and also in CCF without an understorey than with one. [3] Although more abundant in stands with young growth as an understorey (CCF) than as a discrete stand (CFR), goldcrests were also more abundant in CCF stands without an understorey than with one. [4] Common crossbills were also more abundant in CCF without young growth as an understorey than in CCF with young growth as an understorey.

Table 2 Species found in the study for which relationships of abundance and stand structures could not be derived from statistical models (GLMMs).

Species	Statistical testing	Relationship to stand structures
Pheasant *Phasianus colchicus*, robin *Erithacus rubecula*, blackbird *Turdus merula*, song thrush *Turdus philomelos*, chiffchaff *Phylloscopus collybita* and jay *Garrulus glandarius*	Statistical models successfully converged but did not detect any significant differences between stand types	Direction of relationships of abundance with stand structure not determined
Goshawk *Accipiter gentilis*, sparrowhawk *Accipiter nisus*, stock dove *Columba oenas*, tawny owl *Strix aluco*, redstart *Phoenicurus phoenicurus*, wood warbler *Phylloscopus sibilatrix*, willow tit *Poecile montanus*, nuthatch *Sitta europaea*, greenfinch *Carduelis chloris* and hawfinch *Coccothraustes coccothraustes*.	Species too scarce for statistical models to be successfully employed	Exclusively or predominantly in CCF stands
Cuckoo Cuculus *canorus*, whitethroat *Sylvia communis* and linnet *Carduelis cannabina*	Species too scarce for statistical models to be successfully employed	Exclusively or predominantly in young CFR stands

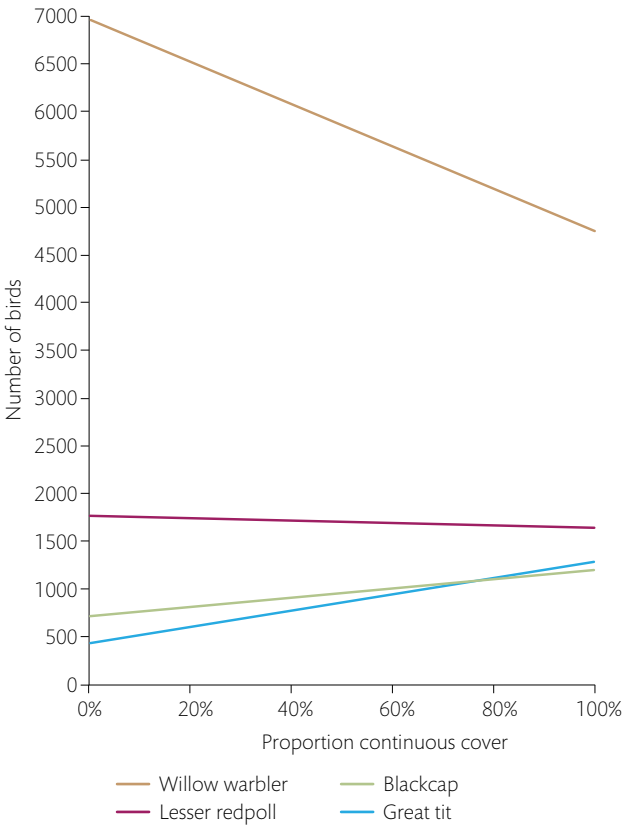
abundantly in the mature stands, and especially those managed as CCF, will include those more forest specialist species. Those species which were found more abundantly in association with young growth areas will include the more shrub specialist species. Among this latter group, there also appear to be some differences. For example, blackcap and garden warbler which might be thought of as 'shrub-layer' specialists are more abundant in shrubs as an understorey (as in CCF) than as a discrete block of shrubland (as in CFR). In contrast, willow warbler and lesser redpoll were more abundant in young CFR stands than in CCF understorey, perhaps suggesting a tendeancy towards being 'shrubland' rather than 'shrub-layer' species.

These differences are not all clear-cut, however, and some are difficult to explain or are the result of indirect correlations. For example, it is unclear why great spotted woodpecker should be more abundant in CCF with a shrub understorey or why treecreeper should be more abundant in old stands of CFR.

Modelled scenarios

The likely effects of increasing the proportion of a forest managed under CCF are based on the recorded densities of four species that show contrasting associations with stand type category. Predicted populations of willow warbler (a migrant apparently associated with shrubs/young trees and most abundant in young CFR) and lesser redpoll (a resident or more locally dispersive species that was most abundant in young CFR) both declined with increasing proportions of CCF. The predictions for great tit (a largely resident species that was most abundant in CCF stands but not apparently associated with a regenerating understorey) and blackcap (a migrant that was most abundant in CCF with a regenerating understorey) were for an increased population to be supported when the proportion of CCF management increased (Figure 4).

Figure 4 Simulated scenarios of increasing the proportion of a conifer forest managed as CCF on the number (vertical axes) of four example species. The model assumes a forest area of 50 km^2 in which one-third of any CCF has a regenerating 'shrubby' understorey and one-third of any CFR is young growth stage (thicket and pre-thicket).



Conclusions and further research

Conifer plantations managed as CCF can support more bird species than those managed as CFR with typical rotations and many of them at higher densities, at least in Sitka spruce dominated plantations in the British uplands. The differences are likely to be associated with different stand structures and

especially how the different age classes of trees are distributed. However, another important difference in the study sites was that CCF tended to include more (naturally reseeded) broadleaved trees, as it is known that the avifauna can be enhanced by the presence of just a few broadleaved trees (Bibby, Aston and Bellamy, 1989; Wilson *et al*., 2010). For some species that tend towards being shrubland specialists, CCF may not be able to support the densities of birds that can be supported within young CFR stands. A further potential disadvantage of CCF, particularly if occupying a high proportion of the landscape, is its unsuitability for birds that favour more open habitats (for example black grouse, hen harrier, short-eared owl and whinchat) which can be supported in young CFR stands but were recorded rarely or not at all in our study areas. Some of these species can occur less frequently in second and subsequent rotation plantings and so this may not be a major conservation issue for established forests.

This study was of forests of plantation origin in upland Britain. Other species are found in the lowlands and further south, some of which find suitable conditions in young CFR including lowland pine forests (for example nightjar *Caprimulgus europaeus*, woodlark *Lullula arborea* and turtle dove *Streptopelia turtur*). This study has also only compared CFR on a typical economic rotation length with CCF and it may be useful to also consider CFR on extended rotations as bird habitat. Further studies to cover this, and including different crop species, geographic locations and different taxa, are needed to fully assess the conservation benefits, or otherwise, of CCF. However, an optimal bird conservation strategy for conifer plantations in the British uplands could be to include CFR with associated young growth areas alongside CCF (that could include some broadleaved trees) as this would provide conditions for both shrub and mature tree dependent species. This would be consistent with approaches considering management at the landscape scale as preferable to stand-based decisions alone.

References

BIBBY, C.J., ASTON, N. and BELLAMY, P.E. (1989) Effects of broad-leaved trees on birds of upland conifer plantations in north Wales. *Biological Conservation* **49**, 17–29.

DU BUS DE WARNAFFE, G. and DECONCHAT, M. (2008) Impact of four silvicultural systems on birds in the Belgian Ardenne: implications for biodiversity in plantation forests. *Biodiversity and Conservation* **17**, 1041–55.

FULLER, R.J., (2012.) Avian responses to transitional habitats in temperate cultural landscapes: woodland edges and young growth. In: R.J. Fuller (ed.) *Birds and habitat: relationships in changing landscapes.* Cambridge University Press, Cambridge. pp. **125–49**.

WILSON, M.W., GITTINGS, T., KELLY, T.C. and O'HALLORAN, J. (2010) The importance of non-crop vegetation for bird diversity in Sitka spruce plantations in Ireland. *Bird Study* **57**, 116–20.

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