

A comparative study of bird communities in coniferous and broadleaved woodland at various stages in the growth cycle

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Abstract

Bird counts were conducted in four coniferous and three broadleaved forests during the 1998 breeding season. Species richness and density at various stages in the growth cycle were determined. Conifers at thicket stage supported the highest number of bird species, which declined thereafter. Species richness in broadleaves increased over the life of the crop and at maturity exceeded that of conifers.

Bird densities in both forest categories increased with crop age, though it was in 15-year-old stands that those in broadleaves equalled, and thereafter exceeded those in conifers. Densities at the studied sites were generally higher than those recorded in previous studies. Census method may account for some of this variation.

Habitat diversity, tree species and vegetation management determined the bird species present. In the interest of species richness these factors should be considered in forest management.

Keywords: Birds, conifers, broadleaves, species richness, species density, forest management.

Introduction

Woodland represents a significant and expanding habitat type in Ireland. Forest cover stands at 606,000 ha or approximately 9% of the land area of the country (Forest Service 1998). The area is scheduled to grow still further in line with government policy as outlined in *Growing for the Future*, A Strategic Plan for the Development of the Forestry Sector in Ireland. Conifers account for 79% of the forest estate, with broadleaves comprising the balance (Forest Service 1998). With an increased emphasis on broadleaf planting their proportion of the forest estate is likely to increase.

Coniferous and broadleaved woodland represent two distinct habitat types supporting different bird communities. The former at maturity is dominated by canopy-dwelling, insectivorous species, whereas the latter has a greater vertical distribution of species in its three vegetation layers – shrub layer, understorey and canopy. The understorey layer is generally absent in coniferous crops (Whelan 1994).

Despite the significance of coniferous woodland ecosystems in Ireland Notwithstanding a recent systematic study of avian biodiversity in Irish coniferous forest (O'Halloran *et al.* 1998, Walsh *et al.* 2000) little research has been conducted on the bird populations of coniferous forest. Some studies have been carried on broadleaved forest, though for varying objectives and employing different techniques (Batten 1996, Duffy *et al.* 1997, Kavanagh 1990, Nairn 1991, Wilson 1977).

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Objectives

The objectives of the study were:

- to assess bird population diversity and density in commercial coniferous forest plantations at various stages of development and compare them with broadleaved plantations at similar stages;
- to describe the successional nature of avian communities in commercial plantations;
- to examine the association between bird populations and tree species or habitat types and
- to examine the impact of management techniques on avifauna.

Materials and methods

Site selection criteria

A random sample of sites was selected from the Coillte inventory system, subject to the criteria outlined below.

Forest development stage

Forests representative of establishment, thicket, pole and mature stages were required. Forests with the following ages were therefore chosen:

conifer	5, 10, 29 and 37 years of age,
broadleaf	5, 21 and 52/58 years of age.

Forest size

Forests with a minimum size of 20 ha (Bibby *et al.* 1992) were specified to facilitate the selection of an adequate number of sampling points and to minimise the influence of adjacent habitats. This was achieved for coniferous crops but broadleaves were only available in the size range 12-17 ha.

Location and altitude

All of the sites chosen were from the same geographic area of the east midlands (the confluence of counties Kildare, Meath and Offaly). The altitude range was from 70 to 90 m.

Forest species composition

Forests comprised of similar species were selected. The coniferous crops all comprised mainly spruce (*Picea*) species. Two were pure Sitka spruce (*Picea sitchensis*), and two predominantly Norway spruce (*Picea abies*) with a small admixture of Sitka spruce and other minor species. The broadleaved crops were predominantly ash (*Fraxinus excelsior*) and beech (*Fagus sylvatica*). One was pure ash; the second was a mixture of ash and beech in separate stands, with a small amount of other species; the third stand was comprised of mixed beech and ash with occasional spruce, and small amounts of other species. Detailed descriptions of the sample sites are presented below.

Site 1: Clonad, Co Offaly (national grid reference N 58 22).

The crop was 26 ha in area and was comprised of 5-year-old pure Sitka spruce, with a potential yield class of 16-18 m³ha⁻¹yr⁻¹. The trees ranged from 1.5 to 2.5 m in height. The associated vegetation consisted mainly of scattered furze (*Ulex* spp) bushes. The Philipstown river formed the northern boundary. The ground vegetation, except for a band 50/60 m wide inside the boundary, had been sprayed resulting in shorter, less dense

growth, with considerable areas where the previous year's dead vegetation mat was still partly exposed.

Site 2: Derryhinch, Co Meath (national grid reference T 54 42).

The crop was 24 ha in area and was comprised of a 10-year-old crop of mixed Norway and Sitka spruce, with a 1 ha plot of pure Sitka spruce. Although it had been assigned a potential yield class of 16-18 m³ha⁻¹yr⁻¹, it was a poor quality crop. Trees ranged in height from 1.2 to 4.6 m. The canopy had not closed. There were occasional open areas devoid of tree cover. Scrub vegetation, in the form of occasional hawthorn (*Crataegus monogyna*), willow (*Salix* spp) and briars (*Rubus* spp), was present. The vegetation had been controlled as at site 1. One boundary was formed by the Mongagh river.

Site 3: Ballysooghan, Co Kildare (national grid reference N 65 21).

The crop was 23 ha in area and was comprised of a 29-year-old crop of pure Sitka spruce, predominantly of yield class 20 to 26 m³ha⁻¹yr⁻¹. The crop had closed canopy and had been thinned, apart from about 10% which had been planted on peat and had a yield class of 10-12 m³ha⁻¹yr⁻¹. This area carried heather (*Calluna vulgaris*) and sphagnum. The vigorously growing crop had some ground vegetation comprised of mosses (*Bryophytes*) and occasional ferns (*Polypodiaceae*). Broadleaved scrub and grasses (*Gramineae*) were present along drains and rides.

Site 4: Colcagh, Co Offaly (national grid reference N 56 23).

The crop was 31 ha in area and was comprised of a 37-year-old crop of Norway and Sitka spruce (80% of the area – both pure and mixed). The remainder of the area carried a crop of Norway spruce mixed with Scots pine (*Pinus sylvestris*), Lawson cypress (*Chamaecyparis lawsoniana*) and Douglas fir (*Pseudotsuga menziesii*) in separate stands. The canopy had closed, there was no understorey and little ground vegetation. Broadleaved scrub and grasses were present along rides. One of the site boundaries was formed by the Philipstown river.

Site 5: Corbetstown, Co Offaly (national grid reference N 53 39)

The crop was 13 ha in area and was comprised of a pure 5-year-old ash crop, ranging in height from 1.2 to 2.5 m. Occasional furze bushes were present, with a hedgerow of furze and hawthorn running alongside a stream. The ground vegetation was comprised predominantly of grasses, meadowsweet (*Filipendula ulmaria*) and silverweed (*Potentilla anserina*). It had been controlled similarly to sites 1 and 2.

Site 6: Killinthomas, Co Kildare (grid reference N 66 22)

The crop was 12 ha in area and was comprised of 21-year-old broadleaves, with 6 ha of beech and 4 ha of ash, in pure stands. The remaining area was comprised of mixed beech, ash, oak (*Quercus petraea*) and birch (*Betula pubescence*). The canopy had closed. Occasional mature trees remained from an earlier rotation. There was no understorey beneath the pure ash or beech. Elsewhere a thin understorey of hawthorn and hazel (*Corylus avellana*) occurred. Here the ground cover was predominantly comprised of garlic (*Allium ursinum*).

Site 7: Donadea Demesne, Co Kildare (grid reference N 83 33)

The crop was 17 ha in area and was comprised of a 52/58-year-old mixed beech and ash stand with a very small quantity of oak, and some Norway spruce scattered throughout. The canopy had closed, except for one sub-compartment where extraction had taken place some years earlier. The understorey was comprised of elder (*Sambucus nigra*), hawthorn

and dense clumps of briars. Elsewhere there was no understorey. The ground vegetation was sparse except along roads where there were grasses, mosses, ferns and vetches (*Vicia* spp).

Method of estimation of bird numbers - point selection

Birds were counted using the point count method. Stratified random sampling was used to locate points so as to include the variations in habitat that occurred at each site. Points were located a minimum of 200 m apart (Bibby *et al.* 1992), and 60 m in from the perimeter to eliminate edge effects. Roads, rides and breaks were treated as an integral part of the forest; where randomly selected points fell within them they were included. These constraints limited the number of points which were included as follows: six points at sites 1, 3 and 4; five at site 2; four at sites 6 and 7 and three at site 5.

Field assessments

All sites were visited twice, between mid-May and mid-June. Counts were conducted between 05.40 and 09.15 hrs. The duration of the counts was 10 minutes, which commenced 3 minutes after arrival at each point. All birds detected, whether by sight or sound – calling or singing – were recorded. Birds in flight were recorded separately. Two circular bands were used – within a 30 m radius and beyond. Habitat was recorded at each point.

Data analysis

The values for total bird densities were derived from combining the two counts at each point by taking the higher count for each species at ranges 0 – 30 m and 0 m to infinity (Bibby *et al.* (1985) and Hill *et al.* (1990).

Bird density was determined as:

$$Density = \log_e \left(\frac{N}{n_2} \right) \times N \{ m(\pi r^2) \}$$

where:

n1 = number counted within the radius

n2 = number beyond the radius

N = total number of birds counted (n1+n2)

m = total number of counts

r = plot fixed radius.

Mean densities were determined by totalling individual densities for each point and dividing by the number of points. Abundance was based on recordings within the 30 m radius.

Results

Species richness

All species recorded at each of the sites are listed in the Appendix. The 5-year-old coniferous crop (site 1) had 23 species recorded - the greatest number in any of the crops. This progressively reduced in the older coniferous crops: to 20 at 10 years (site 2), 15 at twenty nine years (site 3) and 10 at thirty seven years (site 4). The broadleaved crops had 17 spe-

cies recorded at 5 years, dropping to 12 at twenty one years but increasing again to 15 at fifty two years of age.

A core of species – blackbird (*Turdus merula*), chaffinch (*Fringilla coelebs*), robin (*Erithacus rubecula*), songthrush (*Turdus philomelos*), wood pigeon (*Columba palumbus*) and wren (*Troglodytes troglodytes*) – was common to all sites. Wren featured among the three most common species at every site. The 37- and 29-year-old coniferous crops (sites 4 and 3) were dominated by wren, goldcrest (*Regulus regulus*) and chaffinch (in different orders). The 10-year-old coniferous crop (site 2) was dominated by wren, meadow pipit (*Anthus pratensis*) and chaffinch. The 21-year-old broadleaved crops (site 6) were dominated by wren, chaffinch and blackbird; the oldest broadleaved crop (site 7) by goldcrest, blackbird and wren. The most abundant species in both 5-year-old crops (sites 1 and 5) was the ground-nesting meadow pipit, followed by wren and chaffinch in conifer and wren and skylark (*Alauda arvensis*) in ash. Both the 5- and 10-year-old coniferous crops (sites 1 and 2) supported a greater diversity of scrub and ground-nesting species than the 5-year-old ash crop. The three most abundant species at each site and their contribution to the total bird population are outlined in Table 1.

Table 1. The three most abundant bird species and their contribution to the total number of birds at each site.

Species	Coniferous crops								Broadleaved crops					
	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Site 7	
	A ¹	%	A	%	A	%	A	%	A	%	A	%	A	%
Blackbird											3	14	2	14
Chaffinch	3	20	3	11	3	17	3	22			2	14		
Goldcrest					1	27	2	22					1	16
Meadow Pipit	1	23	2	20					1	40				
Skylark									3	20				
Wren	2	20	1	21	2	20	1	24	2	27	1	18	3	13

¹A: order of abundance

Density

Both coniferous and broadleaved crops showed an upward trend in total bird density over the life of the crops (Table 2). The number peaked in the conifer crops at 29 years before falling back in the older crop at the lower age.

Table 2. Relationship between crop type and age, and bird density.

Site	Crop type	Total density	Minimum	Maximum	Mean
birds ha ⁻¹					
1	5-year-old conifer	27.4	12.0	47.7	22.8
2	10-year-old conifer	54.5	11.8	90.1	53.8
3	29-year-old conifer	58.3	11.5	56.4	37.8
4	37-year-old conifer	51.4	21.8	66.1	40.1
5	5-year-old broadleaf	20.1	7.4	17.1	13.6
6	20-year-old broadleaf	76.9	41.9	134.1	70.1
7	52/58-year-old broadleaf	77.8	40.3	162.6	91.6

The oldest broadleaved crop had a statistically higher bird density, 77.8 birds ha⁻¹, than the oldest coniferous crop 51.4 birds ha⁻¹. In the younger crops the opposite was the case. Densities at individual points (maximum and minimum) within the sites showed considerable variation. Densities in recently thinned areas of coniferous crops (site 4) were lower than in unthinned areas. The highest bird density in coniferous woodland was at a point close to a ride where there were some broadleaves and an understorey.

Densities of the three most abundant species at each site are shown in Table 3. The highest densities for individual species were recorded for goldcrest and wren at sites 3 and 2 respectively. Both were also among the highest density species at sites 4 and 7. Chaffinch had the highest density in mature conifers and had higher densities in conifers at all stages than in broadleaves. Blackbird was the most dense species in mature broadleaves. Meadow pipit was among the highest density species in both 5-year-old crops.

Table 3. *Density of the three most abundant bird species at each site.*

Species	Coniferous crops				Broadleaved crops		
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
	<i>birds ha⁻¹</i>						
<i>Blackbird</i>						9.2	16.5
<i>Chaffinch</i>	7.7	10.2	15.7	19.6		10.9	
<i>Goldcrest</i>			23.7	17.3			16.5
<i>Meadow Pipit</i>	7.0	15.6			9.2		
<i>Skylark</i>					4.2		
<i>Wren</i>	7.7	21.0	15.5	16.3	6.2	19.0	11.6

Discussion

Bird densities recorded in coniferous crops were higher in this study than those recorded in the most recent Irish studies by O'Halloran *et al.* (1998), and in earlier studies by Batten (1976), Moss (1978) and Moss *et al.* (1979) in which they ranged from 4 to 36 birds ha⁻¹. Likewise bird densities in broadleaved woodland in this study were higher than those in earlier studies of deciduous and mixed woodland by Massey (1974), Wilson (1977), Kavanagh (1990), Nairn and Farrelly (1991) and Duffy *et al.* (1997), where they ranged between 16.7 and 31.1 birds ha⁻¹. Count methodology may be the reason for the variation as, with the exception of O'Halloran *et al.* and Duffy *et al.*, territory mapping was used. In Britain Moss (1978) and Parsons (1976) recorded densities of 33.3 and 70.3 birds ha⁻¹ respectively in mixed woodland, although the count methodology used is unclear. Duration of counts where point counts are employed may also be a factor given that this variable is not factored into the density equation. This also has an impact upon the diversity of species recorded and is an issue which requires further research. Standardisation of methodology is required for comparative analysis.

This study confirms the pattern and trends established by Moss (1979): the reduced level of bird species diversity in spruce as the crop matures, after the thicket stage. Moss recorded greater species richness in similar sites in Scotland to site numbers 2, 3 and 4 in this study (26, 19 and 12 species respectively, only one of which is not present in Ireland), but poorer species richness at the establishment stage (14 species only). Batten (1976) recorded 14 species in Norway spruce and eight in Sitka spruce. The four coniferous crops in this study supported a total of 30 bird species during the breeding season compared to 31 in seven species of mature conifer (O'Halloran *et al.* 1998). Combining the two studies a

total of 43 species was recorded in coniferous forest over the life of the crops. O'Halloran recorded additional species during the autumn/winter season.

Wilson (1977), Nairn & Farrelly (1991), Duffy (1997) and Kavanagh (1990) all recorded higher species richness in broadleaved woodland than in similar sites investigated in this study – 20 to 34 species – albeit in more diverse woodlands. Comparison with the results of studies by Batten (1976), Moss (1978), Moss *et al.* (1979) – all spruce – and Hill *et al.* (1990) – Scots pine – confirm similar avian communities in mature conifers, dominated by goldcrest, wren, chaffinch, and robin. The most abundant species in the 5-year-old conifers in this study was meadow pipit, confirming findings by Moss *et al.* (1979). Meadow pipit was also most abundant in the 5-year-old ash, with skylark, a species inhabiting a similar niche, although requiring sparser vegetation cover, also among the most abundant species. This may reflect the nature of the ground cover, the management regime which kept it in check and the sparse canopy of ash in the early years. The species which dominate young broadleaved crops reflect the diversity habitat present, as shown by Kavanagh (1990), where reed bunting was amongst the most dominant, indicating an aquatic habitat. The species which dominated mature broadleaves in the various studies were broadly similar but in differing order, and included goldcrest, wren, chaffinch, blackbird, robin, woodpigeon and blue tit.

Forest management implications

Plantation forest ecosystems support a range of avian species which change as the crops mature. At establishment stage the crop is dominated by ground-nesting and scrub species, which are gradually replaced by canopy dwellers in the main.

Diversity of tree species, habitat and age class distribution enhance avian diversity. In the establishment phase (sites 1, 2 and 5) management of ground vegetation was most likely a contributory factor in determining suitability of the sites for meadow pipit, skylark and grasshopper warbler. It was either manually controlled or sprayed with Kerb resulting in conditions suitable for these species. Skylark required less cover than meadow pipit, which in turn required less dense cover than grasshopper warbler, suggesting the need for control on a rotational basis. An uncontrolled area of nettle and low scrub provided habitat for whitethroat (Site 1). Pockets of furze encouraged species such as stonechat and whinchat. Low scrub supported willow warbler, while taller broadleaved trees with reduced ground cover, supported chiffchaff. This points to the value of scrub and broadleaf planting along the edge of rides and roads (also recommended by Walsh *et al.* 2000). Reed bunting was attracted by the presence of water, indicating the value of wetland habitat in attracting specialist aquatic species. It is of note that the highest bird density in conifers was at a point displaying greatest vegetation diversity.

This study highlights the importance of woodland in supporting a range of bird species at the densities described. Taken in conjunction with the other studies quoted the work suggests that mixed woodland, with greater diversity of vegetation, tree species and habitat supports greater avian diversity than pure crops. Rides and roads provide opportunities for introduction of greater habitat diversity particularly regarding broadleaf planting, scrub and open space.

A management programme incorporating ground vegetation control, encouragement of scrub pockets, adoption of a greater mix of species and age classes and the creation of greater habitat diversity should be used to enhance the forest environment to increase bird species richness and density. This strategy has the potential to combine the avian diversity

benefits of the different stages of forest development in a more biodiverse forest.

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APPENDIX

Species recorded at each study site.

Species	Study site						
	1	2	3	4	5	6	7
Blackbird (<i>Turdus merula</i>)	*	*	*	*	*	*	*
Blue tit (<i>Parus caeruleus</i>)			*		*	*	*
Chaffinch (<i>Fringilla coelebs</i>)	*	*	*	*	*	*	*
Chiffchaff (<i>Phylloscopus collybita</i>)			*	*		*	*
Coal tit (<i>Parus ater</i>)			*	*		*	*
Collard dove (<i>Streptopelia decaocto</i>)	*						
Cuckoo (<i>Cuculus canorus</i>)	*	*	*	*	*		
Dunnock (<i>Prunella modularis</i>)	*						
Goldcrest (<i>Regulus regulus</i>)	*	*	*	*		*	*
Grasshopper warbler (<i>Locustella naevia</i>)	*	*					
Great tit (<i>Parus major</i>)			*		*		*
Hooded Crow (<i>Corvus corone cornix</i>)	*				*		
Jackdaw (<i>Corvus monedula</i>)		*					*
Kestrel (<i>Falco tinnunculus</i>)	*						
Magpie (<i>Pica pica</i>)		*					
Meadow pipit (<i>Anthus pratensis</i>)	*	*			*		
Mistle thrush (<i>Turdus viscivorus</i>)	*						*
Pheasant (<i>Phasianus colchicus</i>)	*	*	*		*	*	*
Redpoll (<i>Carduelis flammea</i>)		*					
Reed bunting (<i>Emberiza schoeniclus</i>)	*	*					
Robin (<i>Erithacus rubecula</i>)	*	*	*	*	*	*	*
Rook (<i>Corvus frugilegus</i>)	*	*	*		*	*	*
Skylark (<i>Alauda arvensis</i>)	*	*			*		
Stonechat (<i>Saxicola torquata</i>)	*	*					
Song thrush (<i>Turdus philomelos</i>)	*	*	*	*	*	*	*
Wheatear (<i>Oenanthe oenanthe</i>)	*						
Whinchat (<i>Saxicola rubetra</i>)					*		
Whitethroat (<i>Sylvia communis</i>)	*	*			*		
Willow warbler (<i>Phylloscopus trochilus</i>)	*	*	*		*		
Woodpigeon (<i>Columba palumbus</i>)	*	*	*	*	*	*	*
Wren (<i>Troglodytes troglodytes</i>)	*	*	*	*	*	*	*
Total	23	20	15	10	17	12	15