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An assessment of avian biodiversity and opportunities for enhancement in Ireland's forests: preliminary results

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Abstract

Forest expansion in Ireland has led to concern for the characteristic plant and animal communities associated with the planted land. If carefully planned, however, forestry may provide opportunities for conservation and enhancement of biodiversity. This study sets out to provide systematic data on bird assemblages in Irish plantation forests, and to suggest ways in which the biodiversity, as represented by birdlife, might be enhanced. Preliminary data are presented on the general bird assemblages of 'mature' (pole-stage) forests in southwest Ireland during spring/summer, autumn and winter 1996/97, and on bird/habitat relationships. A total of 38 bird species was recorded within the 20 forest compartments studied, with goldcrest (*Regulus regulus*) being the most abundant and widespread. Some species showed marked seasonal variation in forest usage. Habitat factors which showed a positive relationship to bird species richness and/or bird density included, on varying scales, the number of broadleaf species present, proximity to the forest edge, and the amount of undergrowth. Some bird species also showed evidence of association with particular species of conifer.

Keywords: birds, conifers, tree species, goldcrest, edge

Introduction

Forestry is an important land use in Ireland, and is based primarily on exotic conifers grown over relatively short rotations. With a projected annual planting area of 20-25,000 ha/year (Anon., 1996), the future development of the forestry sector will lead to increased areas of the landscape being afforested, and this will have implications for biodiversity and conservation. Increasing afforestation has led to concern for the characteristic ecological communities associated with the planted land (e.g. Ratcliffe, 1986 & 1990; Nature Conservancy Council, 1986; Hickie *et al.*, 1993). Much of this concern has focused on birds and on fishlife in rivers draining forested catchments. Forest ecosystems can, however, be rich in biodiversity, ranging from microbial to fungal, plant and animal communities. Thus, forest expansion, if carefully planned, may provide opportunities for conservation and the enhancement of biodiversity.

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A project is underway at University College Cork, investigating the enhancement opportunities for birds in forestry and for fish in forested catchments at a range of study sites in Munster (Lehane *et al.*, 1997). In this paper, preliminary data and analyses on bird communities in plantation forests in Munster are presented and discussed.

Bird communities utilise plantation forests at each stage of the forest cycle. Much data has been collected on forest birds in Britain and reviewed by Avery and Leslie (1990) and Petty and Avery (1990) for terrestrial species. Data on aquatic birds in forested catchments have been presented by O'Halloran *et al.* (1990), Ormerod *et al.* (1991) and Smiddy *et al.* (1995). In the case of terrestrial birds, one the strongest criticisms of plantation forestry has been levelled at the loss of breeding moorland habitat for birds such as golden plover (*Pluvialis apricaria*) and red grouse (*Lagopus scoticus*), particularly in Britain (Petty and Avery, 1990). There can also be impacts on other breeding species such as raven (*Corvus corax*) and raptors like merlin (*Falco columbarius*), through the loss of open country used for feeding, even though forests may in some cases provide new nesting habitat (e.g. Parr, 1991).

In Ireland, few published data are available on breeding birds of moorlands. Examination of the most recent data (Gibbons *et al.*, 1993) suggests, however, that it is unlikely that the expansion of forestry will have as significant an impact on moorland birds as that in northern Britain, as fewer individuals or species, particularly of wading birds, are found in equivalent Irish habitats. One of the main reasons for the scarcity of breeding wading birds on many Irish moorlands, particularly in the southern half of the island, may be that these species are at the edge of their breeding ranges (Cramp, 1983). There will, however, be regional differences, the general trend being for an increase in species richness of moorland species from south to north (cf. Avery and Leslie, 1990). Another important factor is that, for historical and biogeographical reasons, the bird species pool in Ireland is relatively small, with few true woodland species (Wilson, 1977; Hutchinson, 1989). Therefore, the impact, positive or negative, of afforestation is likely to be different here than that in Britain. Forest plots also differ, being on average smaller than those in Britain (Heritage Council, 1997) and thus having a relatively greater edge-length, perhaps providing new opportunities for species. The planting of trees in some areas, therefore, may lead to increased opportunities for biodiversity, through the provision of new breeding, feeding and roosting habitats for birds.

This study sets out to collect systematic data on bird assemblages in Irish plantation forests, and also to suggest ways in which biodiversity, as represented by birds, might be enhanced. Most of the work focuses on conifer plantations, which still dominate both semi-state and private planting. New plantings of broadleaf trees are, however, expected to increase, particularly on higher quality land planted by the private forestry sector (Anon., 1996), and further work may be needed to address the potential in this area.

The project began in autumn 1995 and will continue until 1999. The data presented here cover part of the first year's fieldwork, focusing on assemblages and habitat relationships of birds in pole-stage forests during the breeding season, autumn and winter. The results are preliminary, and further analysis is underway. Other phases of the project will examine the influence of tree age, and the size and shape of forest stands, on birds. Sample surveys of some individual species (nightjar (*Caprimulgus europaeus*) and long-eared owl (*Asio otus*)) are also underway.

Methods

Selection and location of study sites

Forests owned by Coillte are being used to provide a representative pool of study sites, by agreement with staff in the company's Cork and Kilkenny regions. The sites were selected following examination of the forest inventory data. For the 1996 field season, 20 sites (compartments) were selected, focusing on randomly selected sub-compartments containing at least 10 ha of a particular age class (30-45 year old trees) of selected conifer species (Table 1). The compartments studied were mainly 15-25 ha in area, with a range of 11-31 ha.

Table 1. *'Target' tree species for the 1996/97 fieldwork.*

Sitka spruce (*Picea sitchensis* (Bong.) Carr.)
Norway spruce (*P. abies* (L.) Karst.)
Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco)
Noble fir (*Abies procera* Rehd.)
Lodgepole pine (*Pinus contorta* Dougl.)
Scots pine (*P. sylvestris* L.)
Japanese larch (*Larix kaempferi* (Lamb.) Carr.)

Marking of sampling points

For each compartment, a 50 m x 50 m grid was traced onto a scaled enlargement of the relevant Coillte forest inventory map, starting from a randomly selected corner (e.g. NE) of the compartment boundary. Points were marked at the intersections of the grid, and those greater than or equal to 30 m from the compartment boundary were numbered in sequence from NE to SE. For the 'main' tree species in the compartment, i.e. the species for which the compartment was selected, an initial random selection of numbered points was made, with a criterion that the points were at least 100 m apart and at least 30 m from sub-compartments containing other tree species. Once these points had been selected, a random selection from the remaining available points was made.

In the field, the selected points were located using a compass, tape and a cord marked at intervals. Each point was marked and numbered with a small plastic tag, painted fluorescent yellow. The approach to each point, along a north-south or east-west line, was marked at frequent intervals with a small piece of coloured twine.

Collection of bird data

Counts were made in 20 forest compartments at a total of 200 points (the maximum number of points possible, given randomisation and the restrictions set out above). Using the methodology described by Bibby *et al.* (1985 & 1992), birds seen or heard within a 30 m radius of each point were noted separately from birds seen or heard beyond that radius and from birds in flight above the canopy. By taking into account differences in the detectability of different species (Bibby *et al.*, 1992), this method allows estimation of bird densities. Data were collected over a 10-minute period at each point on each count-date. For the analyses presented here, bird densities and species composition were based on the second 5-minute period of each 10-minute count (for comparability with British studies by Bibby *et al.* (1985 & 1992)), while bird/habitat relationships were assessed using 10-minute counts or the full site-visits.

Spring/summer (breeding season) data collection

Counts were made twice at each point in each forest compartment, once between mid-April and mid-May, and once between mid-May and mid-June, 1996, to allow for possible seasonal changes in bird detectability and for the late arrival of migratory species. For each point and species, the highest count from the two dates available was used for analysis, following Bibby *et al.* (1992).

Autumn and winter data collection

Points were visited once in autumn (September-October 1996) and up to twice in winter (November 1996 - February 1997), to identify possible seasonal changes in the use of plantation forests by birds.

Collection of habitat data

Standardised data on vegetation were also collected at the study sites for analysis of habitat/bird assemblage relationships. In the first year's study, data were collected on the tree species present, and their relative abundance, within a 30 m radius of each sample point and within each compartment as a whole. Other parameters recorded included percentage ground cover of different vegetation types (e.g. bramble (*Rubus* spp.)) at each point. In this paper, results of a number of univariate analyses (including simple regressions) are presented. A more detailed presentation of habitat variables and results will be provided elsewhere.

Results

Overall pattern: spring and summer

In total, 31 species of birds were recorded within compartment boundaries during the breeding season (Table 2). A number of additional species were recorded in flight only, or detected outside the compartment boundaries, e.g. singing from adjacent hedgerows.

Eight species were recorded in all compartments, with goldcrest (*Regulus regulus*) being the most abundant species, followed by robin (*Erithacus rubecula*) and chaffinch (*Fringilla coelebs*). The average density of birds was estimated at 12.1 birds/ha, of which approximately half were goldcrests. Figure 1 compares the species composition of passerines (excluding species larger than jay (*Garrulus glandarius*)) recorded in this study with data from limited previous studies of breeding birds in Irish conifer plantations. The relative abundance of goldcrests in conifer forests in Ireland is much greater than in broadleaf forests (Figure 1). Studies of 'mature' conifer forests in Scotland found a broadly similar species composition to this study, again with a preponderance of goldcrest. Note that comparisons are based on relative (rather than absolute) densities in Figure 1, due to possible methodological biases in different studies.

Autumn and winter

There were seasonal differences in the utilisation of forests by birds, although some species were widespread during all seasons. A total of 32 species was recorded in November-February 1996/97, with 23 species recorded at a smaller sample of sites in autumn (Table 2). Some species were absent in winter, notably summer visitors such as spotted flycatcher (*Muscicapa striata*). Other (resident) species, such as woodpigeon (*Columba palumbus*) (Figure 2) and song thrush (*Turdus philomelos*), occurred in a higher propor-

Table 2. *Bird species recorded in 20 coniferous forest compartments (mainly 30- to 45-year old trees) in Munster during standardised breeding season, autumn and winter surveys in 1996/97. Species recorded only in flight above the forest canopy, or outside compartment boundaries, are excluded. The list is derived from two morning visits to all 20 compartments in April-June 1996, one visit to nine compartments in September-October 1996, and one or two visits to 19 compartments in November 1996 - February 1997.*

	Apr-Jun	*Sep-Oct*	*Nov-Feb*		*Apr-Jun*	*Sep-Oct*	*Nov-Feb*
Grey heron (*Ardea cinerea*)	+	+	+	Long-tailed tit (*Aegithalos caudatus*)	+	+	+
Mallard (*Anas platyrhynchos*)			+	Coal tit (*Parus ater*)	+	+	+
Sparrowhawk (*Accipiter nisus*)	+		+	Blue tit (*P. caeruleus*)	+	+	+
Kestrel (*Falco tinnunculus*)			+	Great tit (*P. major*)	+	+	+
Moorhen (*Gallinula chloropus*)	+			Treecreeper (*Certhia familiaris*)	+	+	+
Pheasant (*Phasianus colchicus*)			+	Jay (*Garrulus glandarius*)	+	+	+
Woodcock (*Scolopax rusticola*)	+		+	Magpie (*Pica pica*)	+	+	+
Woodpigeon (*Columba palumbus*)	+	+	+	Rook (*Corvus frugilegus*)			+
Wren (*Troglodytes troglodytes*)	+	+	+	Hooded crow (*C. corone*)	+	+	+
Dunnock (*Prunella modularis*)	+	+	+	Raven (*C. corax*)	+		+
Robin (*Erithacus rubecula*)	+	+	+	Chaffinch (*Fringilla coelebs*)	+	+	+
Stonechat (*Saxicola torquata*)	+			Greenfinch (*Carduelis chloris*)			+
Blackbird (*Turdus merula*)	+	+	+	Goldfinch (*C. carduelis*)			+
Song thrush (*T. philomelos*)	+	+	+	Siskin (*C. spinus*)	+	+	+
Redwing (*T. iliacus*)			+	Redpoll (*C. flammea*)	+	+	+
Mistle thrush (*T. viscivorus*)	+	+	+	Crossbill (*Loxia curvirostra*)	+		+
Blackcap (*Sylvia atricapilla*)	+			Bullfinch (*Pyrrhula pyrrhula*)	+	+	+
Chiffchaff (*Phylloscopus collybita*)	+	+					
Willow warbler (*P. trochilus*)	+	+					
Goldcrest (*Regulus regulus*)	+	+	+	Number of species	31	23	32
Spotted flycatcher (*Muscicapa striata*)	+			(overall total 38 species)			

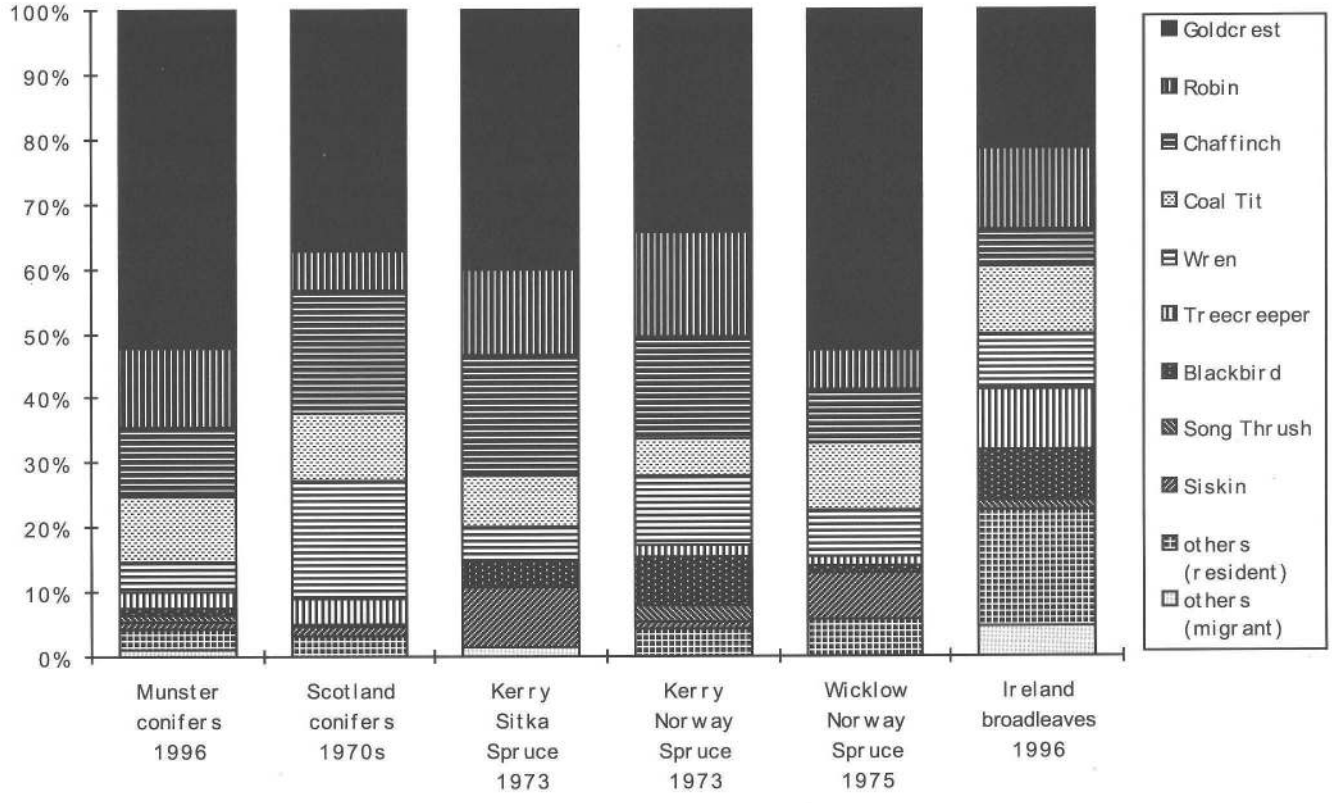

Figure 1. *Percentage composition of the passerine bird assemblages recorded in various 'mature' forests in the breeding season. Sources: Munster conifer and Irish broadleaf forests (this study); Scotland (Moss, 1978a & 1978b); Kerry (Batten, 1976); and Wicklow (Wilson, pers. comm., 1996).*

tion of compartments in spring and summer. Some resident species, notably blue tit (*Parus caeruleus*) (Figure 3), and species whose resident populations are augmented by winter visitors, notably woodcock (*Scolopax rusticola*), were, however, much more widely recorded in winter. Some species present in winter were totally absent from the study sites during the breeding season. These not only included winter visitors such as redwing (*T. iliacus*), but also some residents, such as greenfinch (*Carduelis chloris*) (Walsh *et al.*, 1999).

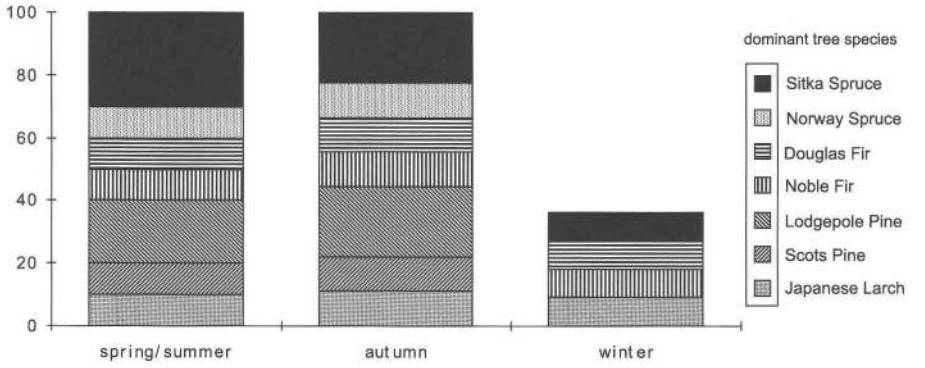

Figure 2. *Percentage occurrence of woodpigeon (*Columba palumbus*) in Munster forest compartments in different seasons, 1996/97 (based on two visits to 20 compartments in April-June, one visit to nine compartments in September-October, and two visits to 11 compartments in November-February).*

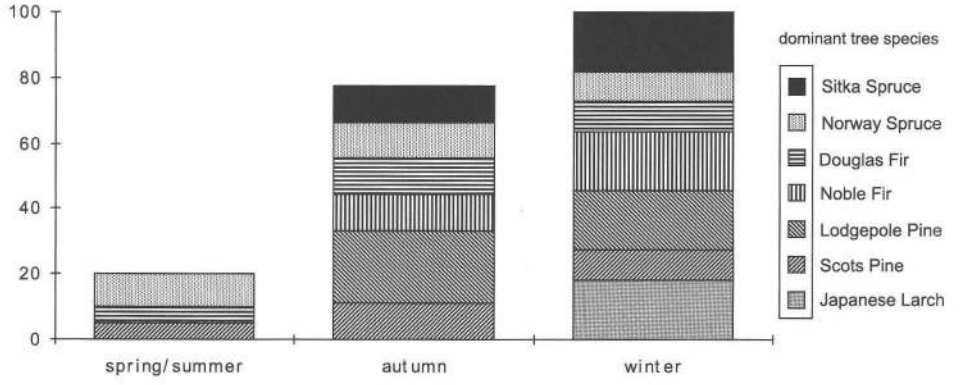

Figure 3. *Percentage occurrence of blue tit (*Parus caeruleus*) in Munster forest compartments in different seasons, 1996/97 (see Figure 2 for sample sizes).*

Influence of tree species

Preliminary analysis suggests that the greatest number of bird species in compartments were associated with Norway spruce (*Picea abies* (L.) Karst.) and Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco), with fewer in Sitka spruce (*P. sitchensis* (Bong.) Carr.) and lodgepole pine (*Pinus contorta* Dougl.) during spring/summer. Broadly similar patterns were seen in autumn and winter. The possible influences of altitude or other factors (e.g. soil type, edge length or associated broadleaf trees) must, however, also be considered, and further analysis is underway.

There was a significant positive relationship ($r = 0.63$, $p<0.01$) between the number of bird species and the total number of tree species during the breeding season within a compartment. This relationship seemed to be explained largely by the number of broadleaf species (including shrub and understorey layer) within a compartment ($R^2 \times 100 = 62\%$, $p<0.001$). No significant relationship was found between the number of bird species and the number of conifer species at either the compartment ($R^2 \times 100 = 0.7\%$) or the point-count level.

For an initial analysis of tree species preference, a comparison was made of the frequency of occurrence of goldcrest and coal tit (*P. ater*), two of the most characteristic and abundant bird species of conifer plantations, at points where different conifer species predominated. Goldcrest occurrence varied significantly (chi-squared (df 6) = 39.72, $p<0.001$) in relation to tree species, with spruces and firs apparently favoured. Coal tits also showed a significant (chi-squared (df 6) = 12.6, $p<0.05$) variation in occurrence between different conifer species, apparently favouring lodgepole pine and Noble fir (*Abies procera* Rehd.).

Influence of distance from edge or rides

Approximately half of the points studied were within 50 m of a ride greater than 4 m in width, or an open space greater than 5 m x 5 m in area. During the breeding season, the points nearest such edges held, on average, slightly but significantly more species within a 30 m radius than points greater than 50 m from the edge ($d = 2.01$, $p<0.05$).

Influence of ground vegetation

Over the range of forest compartments studied, ground cover varied from almost bare (needles or moss with some brash) to extensive bramble cover. One bird species which appeared to benefit from the presence of brambles in this study was wren (*Troglodytes troglodytes*), numbers of which showed a positive relationship to the percentage bramble cover (Figure 4).

Discussion

As noted earlier, this paper is based on preliminary data collection and analysis, with results limited to 20 sites of a particular age class of tree. Further data on different age classes will give a more complete picture of species utilisation of plantation forests in Ireland. The authors also recognise that other factors such as altitude, soil type, availability of nesting sites, etc. have not been included in this analysis.

The most dominant bird species found in the Irish forests studied to date (Figure 1) are broadly similar to those found on agricultural land (Lysaght, 1989; Moles and Breen, 1995; Holt, 1996), with the exception of some additional forest specialist species and the absence of 'open-country' species such as skylark (*Alauda arvensis*). The species diver-

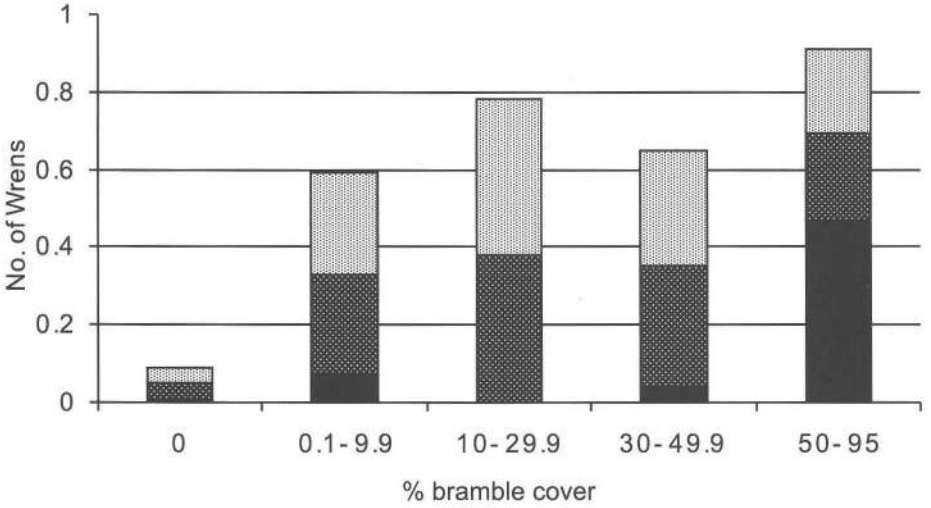

Figure 4. *Number of wren (*Troglodytes troglodytes*) recorded within a 30 m radius during breeding season in relation to the percentage bramble cover (based on the highest of two 10-minute counts at 200 points in Munster forests). Mean peak counts ± 95% confidence limits are shown.*

sity of conifer forests in Ireland may to some extent be limited by the species pool available for colonisation, rather than any intrinsic property of the forests themselves, though the size of the forests and distance from the edge may be important. Comparison of population densities between habitats, and between studies, is complicated by differences in methodology. Some tentative comparisons, particularly of species diversity, can, however, be made. For example, Lysaght (1989) recorded 33 breeding bird species on five farmland plots totalling 181 ha in Co. Limerick, with an average density of 2.7 breeding territories (5.4 breeding birds, excluding woodpigeon)/ha. The species total is broadly similar to the number of species 'using' the forest plots in this study (31 species recorded in 380 ha), with breeding densities apparently higher in the forest (12 birds or 6 territories/ha). In fact, species diversity of forested areas containing a range of tree age classes can be expected to show even higher species richness than this (Petty and Avery, 1990). Furthermore, the breeding diversity and density of birds on farmland may be reduced markedly where hedgerow availability is reduced (Moles and Breen, 1995). The conservation value of forested land relative to intensively farmed land may thus be greater than is generally appreciated.

Comparisons with the results of Batten (1976) and Wilson (pers. comm., 1996) in Irish conifer plantations (Figure 1) show a similar pattern for bird assemblages during the breeding season. In each case, goldcrest was the most abundant species, generally followed by robin, chaffinch, coal tit and wren. Bird densities recorded by these authors were within the range 10-18 territories (20-36 breeding birds)/ha. These figures suggest higher densities than those recorded in this study, although different methodology (territorial mapping versus point counts) and the wider range of tree species studied here, may

account for at least some of these differences. The densities, however, of breeding goldcrests in these earlier studies ranged from 3.8 to 5.9 territories (7.6-11.8 birds)/ha, which are broadly similar to the overall estimate (6.1 birds/ha) recorded in this study.

The most obvious difference in results between this study and other studies of Irish broadleaf forests (Batten, 1976; Wilson, 1977; Nairn and Farrelly, 1991; Carruthers and Gosler, 1995) is that fewer goldcrests were recorded in broadleaves than in conifers. The studies of deciduous forests recorded a higher density of some resident species, notably blue tits and great tits (*P. major*) (for which few nest-holes are available in conifer forests), and also generally higher densities and diversity of migrant species than in 'mature' conifer forests.

The bird species composition in this study is also broadly similar to those for mature plantations in Scotland (Moss, 1978a & 1978b), although the latter studies recorded proportionately more wrens, possibly reflecting differences in ground cover. Research in Wales has concentrated on edges and deciduous patches in conifer forests (Bibby *et al.*, 1989), or on young re-afforested stands (Bibby *et al.*, 1985). In each case, a higher proportion of migrant birds was recorded than in older conifers in either Ireland or Scotland. Another phase of the current study is focusing on younger forests, and comparisons will be published elsewhere.

Interesting temporal differences in the avian usage of Irish conifer forests were noted, with some species apparently more widespread during the spring/summer (e.g. song thrush) and others in autumn and winter (e.g. blue tit). These temporal differences are in part explained by the nesting or feeding requirements of different species, which conifer plantations may not always provide during a given season. Also, dispersal of juvenile birds after the breeding season may lead to some species becoming more widespread. Another factor is that some species are less readily detectable outside of the breeding season. More obviously, seasonal differences also reflect migratory movements of some species. There are no comparable published Irish data for winter bird assemblages in conifer forests, although some relevant data have recently been published for western England (Donald *et al.*, 1997).

Some bird species of considerable conservation interest may rely exclusively, or heavily, on conifer plantations. Forestry practices may thus provide an opportunity to enhance the conservation status of such species. This is particularly true in the case of the crossbill (*Loxia curvirostra*), which has benefited greatly from increased afforestation and is now widely, if sparsely, distributed in Ireland. This species occasionally 'irrupts' in large numbers from continental Europe, and many of these birds remain to breed in Irish conifer plantations, which also maintain a pool of breeding birds between irruptions (Sharrock, 1976; Gibbons *et al.*, 1993). While mature stands are important habitats for crossbill, younger (mainly 1- to 10-year old) conifer plantations now appear to be the most important habitat of breeding nightjars in Britain, aiding their recovery from an earlier decline (Morris *et al.*, 1994). The nightjar is listed in the Irish Red Data Book (Whilde, 1993) as very rare, having declined markedly since the 1950s, with perhaps as few as 30 pairs breeding annually. Young forests may thus be of particular importance to the conservation of the species in Ireland.

Given the paucity of natural or semi-natural woodland in Ireland, conifer forests may also contribute to the conservation of common bird species. Although coal tits are abundant in Ireland, they represent a native subspecies (*P. ater hibernicus*) (Hutchinson, 1989) for which conifer plantations provide a favourable habitat, perhaps even a refuge, where competition with other tit species is reduced. Another example is song thrush, a species

which has declined markedly in Britain (Thompson *et al.*, 1997). The widespread occurrence of this species in Irish conifer plantations may indicate that these forests could compensate in part for the loss of other breeding habitats.

Much has been written about the importance of edge effect in ecology and in forestry. The edges between vegetation types (ecotones) are generally more diverse in their flora and fauna than separate habitats (Pianka, 1974; Burgess and Sharpe, 1981). The preliminary data from this study suggest that there were more bird species near the forest edge, perhaps reflecting factors such as increased habitat diversity and light penetration, both of which influence food availability. Another phase of the ongoing project will study in more detail the possible influence of the shape and edge-to-area ratio of forest blocks.

This study provides some preliminary indications as to how Irish forests might be enhanced for avian biodiversity:

1. The species of conifer will influence the abundance of individual birds and species. The selection of tree species should therefore include consideration of a biodiversity component.
2. The number of broadleaf tree species (including shrubs or undergrowth) may influence the number of bird species. The inclusion of more broadleaves in planting could therefore improve bird species richness.
3. The extent of the forest edge may be important for the number of bird species. Changes in plot size or shape to increase edge may maximise avian biodiversity, although the minimum area required for other types of fauna must be considered.
4. The type and extent of shrub layer influence the abundance of some species. Increasing the light penetration to encourage ground cover should increase both the diversity and density of birds.

At the end of the ongoing project, a more complete assessment will be made of the potential for such enhancement, drawing both on new Irish data and on research from other countries (Jardine, 1988; Avery and Leslie, 1990; Hunter, 1990; Peterken, 1993; Fuller, 1995).

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