Avian distribution patterns in North Humberside woodlands: the role of habitat and landscape-scale factors revisited

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Abstract

Avian distribution patterns in small woodlands in an agricultural landscape were investigated simultaneously at two spatial scales using nested sampling. Correlation, regression and multivariate statistics were used to examine factors influencing bird species' distribution patterns. At the landscape scale, woodland area and isolation were identified as the most important factors influencing birds whilst at the habitat scale vegetation structure was found to be important. Whilst these results demonstrated that the effects of habitat and landscape structure were largely intuitive, there were demonstrable effects of landscape and habitat structure at the 'wrong' scale. Implications for detecting effects of scale on woodland bird species were considered.

Introduction

Regression is a tool which has commonly been used to investigate patterns of bird distribution in woodlands at the landscape-scale with particular attention being paid to the functional significance of the species-area relationship. Habitat-scale factors have often been found to play a subordinate role to regional-scale landscape factors in their influence on bird species richness in such analyses. However, the prominence of patch area in previous studies may be an artefact of experimental design since the inclusion of variables which operate at quite different scales results in a loss of precision at finer resolutions when habitat-scale measures are averaged out over a patch in analyses. In this study, I investigate patterns in woodland bird distribution using a nested sampling approach to discriminate between factors which influence bird species richness at habitat and landscape scales.

Methods

North Humberside has only 2.6% broadleaved woodland cover; much of which is aggregated in an archipelago on the higher ground of the Wolds. North Humberside is a region with few extant non-woodland trees and with few, often heavily managed, hedgerows. Accordingly, the mainland-island analogue offers a representative model to explain the factors influencing bird distribution at the landscape and habitat scales. In this study, woodlands were chosen to represent a range of woodland types in terms of size (0.6 - 48.8 ha), isolation (0 - 12.5 km) and variation in vegetation structure and composition. Woodlands were sampled simultaneously at the local and regional scales by locating 42 sampling stations in 13 woodlands at a rate commensurate with patch area (Spearman's $r_s = 0.86$, $p<0.001$).

Breeding bird numbers were estimated at each sampling station using point counts of five minutes duration between mid-March and late June 1985. Sampling stations were censused on four separate visits with birds recorded within a radius of 25 m. Analyses were undertaken on numbers of breeding species in several functional groups. Vegetation structure was quantified in 0.04 ha circular areas centred on the sampling stations. Vegetation data was reduced by Principal Components Analysis (PCA) and bird data subjected to TWINSPAN. Correlation and regression were used to discriminate between the effects of landscape and habitat influences on bird species richness and patterns of distribution.

Results

Nineteen tree and shrub species were recorded with the dominant canopy tree species being oak (*Quercus robor*), sycamore (*Acer pseudoplatanus*), ash (*Fraxinus excelsior*) and elm (*Ulmus procera*); hawthorn (*Crataegus monogyna*) and elder (*Sambucus nigra*) were common components of the shrub layer. PCA reduced the original 12 vegetation variables down to four new variables accounting for 71.2% of the variation in structure. In order of decreasing importance, the principal components could be interpreted as gradients in: (i) stand maturity, (ii) foliage complexity, (iii) standing dead wood (snags) and (iv) shrub layer vegetation. There were no significant relationships between the first two PCA components and landscape variables although significant correlations between the third and fourth PCA factor scores against isolation and area, were detected (for full results see poster).

Forty one bird species were recorded in a total of 1021 registrations. The seven most common species in terms of numbers of registrations were: Chaffinch (*Fringilla coelebs*)(17.1%), Wren (*Troglodytes troglodytes*)(15.4%), Blue Tit (*Parus caeruleus*) (10.5%), Willow Warbler (*Phylloscopus trochilus*) (8.9%), Blackbird (*Turdus merula*) (7.6%), Robin (*Erithacus rubecula*) (5.8%) and Blackcap (*Sylvia atricapilla*) (5.5%). Thirty four resident species accounted for 81% of the registrations.

Individual woodlands supported between 10 and 32 breeding bird species. There was a significant relationship between numbers of bird species and woodland area (TS: $r_s = 0.59$, $p < 0.05$), but since numbers of species were also related to sampling time (TS: $r_s = 0.59$, $p < 0.05$) partial correlation analysis controlling for sampling time was carried out to reveal a statistically non-significant association between numbers of species and patch area (TS: $r = -0.39$). However, a significant relationship with local isolation was maintained (DN4: $r = -0.66$, $p=0.018$).

TWINSPAN separated sites by a size threshold of approximately 10 ha distinguishing between archipelago and isolated localities. Bird distribution at the landscape scale could be split into three functional groups: forest specialists (e.g., Long-tailed Tit *Aegithalos caudatos*, Woodcock *Scolopax rusticola*), those species largely restricted to aggregated or larger woodlands within the archipelago; a group of ubiquitous species which were abundant irrespective of woodland area and isolation; and a group of farmland species characterised by the presence of birds nesting in woodland but using adjacent habitats as a food source, e.g., Rook (*Corvus monedula*), Woodpigeon (*Columba palumbus*), Linnet (*Carduelis cannabina*), Yellowhammer (*Emberiza citrinella*) and Starling (*Sturnus vulgaris*). Patterns in the distribution of these bird groups at this scale bore no apparent relation to their nesting requirements (Table 1). DCA of bird data at the habitat scale generated four factors which bore some, but not complete, correspondence to the vegetation factors (Table 2).

Discussion

There are limitations of drawing conclusions from short-term studies, although such conclusions are strengthened if the pattern is repeated in subsequent years or in independent studies. The results presented here support a previous study undertaken in the same area using a different approach and study sites (McCollin 1993). The major factors at the landscape-scale were patch area and regional isolation while a number of vegetation-related factors were significant at the habitat-scale. Whilst, these results were intuitive, it is worth noting that the effects of factors considered to operate at a particular scale were detectable at the other scale. Scale is an important factor in habitat selection and, although the approach here using nested sampling shows some promise, further work is required in this area.

References

McCollin, D. (1993) Avian distribution patterns in a fragmented wooded landscape (North Humberside, U.K.): the role of between-patch and within-patch structure. *Global Ecology and Biogeography Letters* 3: 48-62

Table 1. TWINSPAN analysis of bird data in sample woodlands. The table is ordered to display the underlying structure in the data. Figures in the table representing five levels of abundance. Woodland size categories - 1: 0-1.9 ha, 2: 2-4.9 ha, 3: 5-9.9 ha, 4: 10-19.9 ha, 5: 20-50 ha). DA4 isolation classes - 1: 0-1.9 km, 2: 2-4.9 km, 3: 5-9.9 km, 4: 10-20 km. Location of nest sites are indicated in parentheses - C: canopy/shrub nesters, F: ground/field nesters, and H: hole-nesters.

Site Code	ABCDEF	GHIJKLM	
Size class	533553	3542111	
Species Isolation class	111424	1114444	
LONG-TAILED TIT (C)	11----	-------	Aegithalos caudatos
NUTHATCH (H)	3-----	-------	Sitta europaea
WOODCOCK (F)	1--1--	-------	Scolopax rusticola
BULLFINCH (C)	---2--	-------	Pyrrhula pyrrhula
CUCKOO (F)	---3--	-------	Cuculus canorus
MISTLE THRUSH (C)	---1--	-------	Turdus viscivorus
MALLARD (F)	---2--	-------	Anas platyrhynchos
CHIFFCHAFF (F)	-213-2	-1-----	Phylloscopus collybita
TREECREEPER (H)	1-231-	---11--	Certhia familiaris
GREENFINCH (C)	--1122	---1---	Carduelis chloris
KESTREL	--1111	1------	Falco tinnunculus
JACKDAW (H)	2-22--	----1-1	Corvus monedula
Gt Sp WOODPECKER (H)	3225-2	-3--2--	Dendrocopos major
WILLOW TIT(H)	2-12--	--1----	Parus montanus
CARRION CROW (C)	322121	-1-1---	Corvus corone
STOCK DOVE (H)	1222--	-1-----	Columbus oenas
GARDEN WARBLER (F)	--1342	-122---	Sylvia borin
TREE SPARROW (H)	---2-2	---2---	Passer montanus
GREEN WOODPECKER (H)	----2-	-1-----	Picus viridis
SONG THRUSH (C)	432522	1321--1	Turdus philomelos
SPOTTED FLYCATCHER (C)	2313-1	121---1	Muscicapa striata
BLACKCAP (C)	244445	3232-22	Sylvia atricapilla
WREN (F)	445555	3534423	Troglodytes troglodytes
BLACKBIRD (C)	444544	3233223	Turdus merula
BLUE TIT (H)	435554	3333434	Parus caeruleus
GREAT TIT (H)	324422	12-1222	Parus major
ROBIN (F)	224544	323-313	Erithacus rubecula
DUNNOCK (F)	-11332	--22121	Prunella modularis
WILLOW WARBLER (F)	224554	2342321	Phylloscopus trochilus
CHAFFINCH (C)	545555	5453434	Fringilla coelebs
STARLING (H)	--13-3	3---2-1	Sturnus vulgaris
PHEASANT (F)	--1421	231-211	Phasianus colchicus
GOLDCREST (C)	21-2--	222----	Regulus regulus
JAY (C)	1--1-1	-21----	Garrulus glandarius
TURTLE DOVE (C)	---11-	--1-1--	Streptopelia turtur
COAL TIT (H)	1-----	221----	Parus ater
YELLOWHAMMER (F)	------	1-1----	Emberiza citrinella
TAWNY OWL (H)	------	1------	Strix aluco
LINNET (C)	----1-	2------	Carduelis cannabina
ROOK (C)	------	----525	Corvus frugilegus
WOODPIGEON (C)	------	2-----2	Columba palumbus

Table 2. Loading of bird species on DCA axes analysed at scale of sampling stations with correlations versus habitat and landscape variables. Interpretations of the gradients are indicated below. Significance: * p<0.05; ** p<0.01; *** p<0.001

AXES	DCA1	DCA2	DCA3	DCA4
Eigenvalue	0.31	0.12	0.07	0.05
SPECIES	Rook	Woodpigeon	Mallard	Bullfinch
AT +VE	Robin	Linnet	Nuthatch	Mallard
END OF DCA	Chaffinch	Coal Tit	Carrion Crow	Pheasant
AXIS	Pheasant	Kestrel	Jackdaw	Linnet
	Blue Tit	Pheasant	Long-tld Tit	Garden Warbler
	Wren	Goldcrest	Gt Sp Woodpckr	Dunnock
	.	Willow Tit	Treecreeper	Greenfinch
	.	Woodcock	Tree Sparrow	Tree Sparrow
	.	.	.	.
	.	.	.	.
	Willow Warbler	.	.	.
	Woodcock	.	Woodcock	Chiffchaff
	Garden Warbler	Turtle Dove	Stock Dove	Carrion Crow
SPECIES	Turtle Dove	Greenfinch	Kestrel	Spotted Flycatcher
AT -VE	Coal Tit	Tree Sparrow	Bullfinch	Nuthatch
END OF DCA	Cuckoo	Starling	Chiffchaff	Long-tailed Tit
AXIS	Jay	Tawny Owl	Tawny Owl	Stock Dove
Correlations	TDEN 0.49**	IVCONF 0.66***	FHD -0.47**	TOTBAS -0.49**
with	FHD -0.48**	SPCG -0.37*	PCA2 -0.43**	IV>130 0.47**
habitat	PCA2 -0.44**	IVDEAD -0.35*		PCA1 -0.42**
variables		PCA1 -0.32*		DISTEDGE -0.34*
Correlations	AREA -0.37*	DA4 -0.36*		DN4 0.37*
with		DN4 -0.31*		
landscape				
variables				
Interpret-	components	deciduous	foliage	large trees/
ation of	of stand	(Particularly	height	distance to
gradient	maturity /	dead trees) -	diversity	edge / isolation
	Area	coniferous		