BTO RESEARCH REPORT 531

Estimates of breeding bird abundance and habitat use in Thetford Forest Park.

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Estimates of Breeding Bird Abundance and Habitat Use in Thetford Forest Park

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1. INTRODUCTION

This report presents the results from a breeding bird survey carried out in Thetford Forest Park in 2008. The main aims of this survey are to a) assess the importance of bird populations in Thetford Forest for the conservation of Birds of Conservation Concern (BoCC) (Gregory *et al.* 2002) and UK BAP Priority Species, b) determine breeding bird densities and species diversity within different habitat types and management regimes and c) to establish a baseline for future monitoring.

The results of this study will also be considered in conjunction with the results of a baseline bird survey, undertaken as part of a UEA-led study into the effects of deer management on bird communities and habitat structure, in 2007 and 2008, hereafter referred to as the 'Deer Project' (Dolman 2006, Hewson *et. al. in prep.*). However, the Deer Project only covered three of the nine growth stages/ habitats covered but the complimentary coverage was considerable.

Thetford Forest falls within the Breckland SPA that has been designated for Stone Curlew, Nightjar and Woodlark breeding populations. However, in addition to containing large populations of these ground-nesting species that are found in the felled and 'restock' areas where trees are absent or have been recently planted, the forest is at least locally important for other species in later growth stages, such as Firecrest, Hobby, Goshawk and Crossbill. In addition, there is anecdotal evidence of high populations of species of conservation concern, such as: Turtle Dove, Tree Pipit, Yellowhammer, Willow Warbler, Song Thrush, Skylark, Linnet, Dunnock and Green Woodpecker. For some of these species the forest may act as a refuge and possibly contain higher densities than the surrounding agricultural land.

The main aims of this study are to determine relative densities for breeding bird species within the managed forest and identify the most important forest habitats and growth stages, based on relative density. In addition, indicative species population estimates will be calculated for Thetford Forest Park.

2. METHODS

2.1 Survey Sampling Design

The habitats to be sampled includes: Heaths - re-created Brecks heaths, Felled/Unplanted - pre-plant clearfell; Restock; Pre-thicket, Early thicket; Late thicket; Pre-fell; Continuous cover forest; Wet woodland, as derived from the Forestry Commission sub-compartment database (Table 1). These will be both complimentary to and inclusive of the habitats of pre-thicket, thicket and pre-fell, being sampled in the recent Thetford Landscape Deer Study.

As these habitats are taken from the Forestry Commission sub-compartment database, which is primarily aimed a commercial tree crops, the actual composition of tree species may differ. Sub-compartments coded as 'Open' were excluded from the analysis as the habitat within these varies considerably, mainly comprising unplanted habitats, however, those containing Birch regeneration were included as they represent a relevant forest habitat, albeit created unintentionally.

Survey squares were selected to include representative samples of all nine primary habitats and distributed to cover representative samples of core and outlying blocks (Figure 1) and also underlying soil types.

2.2 Field Methods

Two visits were made to each of 45 1-km survey squares: the first between 1st May and 15th June and the second between 16th June and 15th July, with at least two weeks between visits.). Visits were conducted between 0600 hrs and 1100 hrs, to coincide with the main period of bird song and breeding activity. The period of peak activity between pre-dawn and 0600 hrs was avoided, as it is difficult to record all vocal individuals and detect distant and quiet song. Up to two transect lines were selected in each survey 1-km square, where possible, a minimum of 150 metres apart. The sub-compartment was the sampling unit, within which all relevant registrations were plotted in relation to the transect line. An ideal route was suggested for each transect, being a direct line across the 1-km squares, each at 250 metres from the edge of the square. However, due to habitat impenetrability and access, the ideal route was modified, which in many cases meant following tracks and rides along compartment boundaries. During field surveys, each transect was walked at a slow to medium pace and the location of the point of first detection only for each bird heard or seen was recorded on a 1:2,500 map, which included sub compartment boundaries, labelled with Tree species and age - to aid navigation. Activity codes, based on those of the Common Bird Census (Marchant 1983), were used to permit identification of simultaneously singing birds to be differentiated during data extraction. A total of 11 observers undertook the surveys, all of which were experienced in identifying woodland birds by sight and sound.

2.3 Habitat Structure

Structural data on all planted/felled sub compartments was collected to help interpret variation in bird densities within different stands and forest blocks. These included categories for canopy and understorey structure (Appendix 2).

2.4 Data Methods and Analysis

The locations of all birds detected (by sight or sound) were plotted using ArcMap 9.2 GIS (ESRI). The total number of birds recorded and the number singing within 0 - 25 metres, 25 - 50 metres, 50 - 75 metres and 75 - 400 metres of the transect lines during each visit to each plot was extracted by species. The total area surveyed within 25, 50, 75 and 400 metres of the transect lines within each plot was calculated by overlying buffers around the transect lines onto the plot boundaries using ArcMap 9.2 GIS. Where the buffers from adjacent transect lines within the plots overlapped (where transect

lines were less than 150 metres apart), the buffers were dissolved within the area of overlap so that the actual area surveyed could be calculated.

Over all densities of each species for each growth stage were calculated by using Generalised Linear Mixed Models (GLMMs) to model raw count data. All records of juveniles and individuals only noted in flight have been excluded, as they do not relate to breeding individuals.

Growth stages, as defined in the Deer Project, were used to permit calculation of comparable densities between the two studies. Distance sampling was considered but this method is not ideally suited for use in heterogeneous environments, as highlighted by the Deer Project, and even less applicable to sampling with transects within sub-compartments.

Where sufficient data existed, densities were based on singing individuals only to account for differences in detectability between singing and non-singing individuals and to allow estimates to be produced in terms of singing males - analogous to the territories used in territory mapping techniques. Where the number of singing registrations was too low to allow this, densities were produced based on the total number of birds detected.

2.5 Relative Density Estimates and Habitat Association

GLMMs were used to model density using the maximum count of a species in each sub compartment within 50 or 75 metres of the transect lines as the dependent variable. The count was modelled using a Poisson error structure and a log link function, with the area surveyed within 50 or 75 metres as an offset and observer included as a random factor. Observer was included to account for differences between observers in the proportion of individuals they record. Type 3 tests for significant fixed effects of structural and spatial variables (growth stage, understorey distribution (Appendix 2B), stand structure (Appendix 2C – 1 - 3) and forest block) were made for each species. Only those variables showing significant effects (P <0.05) were included in final species models. Estimates of density and associated upper and lower confidence intervals, of each species when singing or for all birds per hectare were then produced from the back-transformed least square means estimate for each level of growth stage and forest block.

2.6 Comparison of Bird Densities with the Deer Project

GLMMs used the maximum count of a species in each sub compartment within 50 or 75 metres of the transect lines as the dependent variable. In most cases, the number within 50 metres is most appropriate for density estimation but the count within 75 metres was used for species where the number of registrations did not fall-off outside of 50 metres (e.g. some thrushes which were detectable from long distances and are known to react to the presence of an observer). Count data from greater than 75 metres from transects was not used for modelling purposes as registrations were less than the 50 and 70 metre buffers due to less consistent coverage and reduced detection. The count was modelled using a Poisson error structure and a log link function, with the area surveyed within 50 or 75 metres as an offset and observer included as a random factor. Observer was included to account for differences between observers in the proportion of individuals they record. Models included forest block and growth stage as fixed effects. Either blocks or growth stages with no birds recorded were excluded from analyses where necessary for model convergence and were assigned a density of zero. Estimates of density and associated upper and lower confidence intervals, of each species in singing, or all, birds per hectare were then produced from the back-transformed least square means estimate for each level of growth stage and forest block (if included in the model).

2.7 Population Estimates

Population estimates and confidence intervals were calculated for all species, which could be adequately modelled, either using maximum male counts or maximum of all registrations. The density of each species within the area of each primary habitat covered was multiplied-up by the area not

covered. The estimates and confidence intervals for each primary habitat type were then summed across primary habitats to give a population estimate for the whole forest.

3. RESULTS

3.1 Survey Coverage

All core and most outlying forest blocks, except Diddlington (Table 2), received coverage broadly in relation to their size. In total, 45 1-km survey squares were covered. Within the 45 1-km survey squares, two individual transects were completed in 32 squares, one individual transect in six squares (mainly where more than a third of the area was non-woodland habitat) and a single combined transect in seven squares (i.e. wet woodland where routes either side of the river channel were combined into a single transect).

In total, a minimum of 5.3% of Thetford Forest Park was intensively surveyed; within 75 metres of all transect routes (Table 3). A minimum of 3.0% coverage of each of the nine primary habitats was achieved, ranging up to 8.6% (restock and other) for all, apart from heathland where 24.7% was covered.

3.2 Bird Data

A summary of all species and individuals recorded during 2008 is summarised in Table 3.

3.2.1 Relative density estimates and habitat association

The density estimates calculated for all species, which could be adequately modelled across the nine primary habitat types, are shown in Figures 2-7. These plots show the relative differences in density between the nine growth stages and habitats. Where there was insufficient, or no data, to model density within a habitat or growth stage, a value of zero was assumed.

The presence of structured understorey was important for Blue Tit, Chiffchaff, Chaffinch, Long-tailed Tit, Robin and Song Thrush (Table 7), within the mature (continuous cover and wet woodland) stands. A positive association with the presence of large, rather than small patches or absent understorey was found for Blue Tit, Chiffchaff, Coal Tit, Jay, Marsh Tit, Robin and Wren (Table 7).

The majority of species fall into five distinct successional stages of woodland (Table 1), as defined by the primary habitat in which the highest densities occur. These consist of:

a) Late successional – Robin, Wren, Chiffchaff, Coal Tit, Goldcrest, Wood Pigeon, Treecreeper, Great Spotted Woodpecker, Blackbird, Bullfinch, Great Tit, Goldcrest, Mistle Thrush, Long-tailed Tit, Blue Tit, Jay, Stock Dove, Marsh Tit and Siskin.
b) Mid-successional – Yellowhammer, Willow Warbler, Dunnock, Song Thrush, Turtle Dove,
c) Early successional – Tree Pipit, Woodlark, Whitethroat, Dunnock and Linnet.
d) Open – Skylark, Stonechat, Kestrel and Cuckoo (probably related to host distribution – Dunnock) .
e) Multiple stages – Chaffinch, Blackcap, Whitethroat, Garden Warbler, Carrion Crow, Greenfinch and Green Woodpecker.

3.2.2 Species richness

An indication of the species diversity within the primary habitats is presented in Table 6, which gives that total species count, from all registrations, for each. Mature has by far the greatest number of species (62), followed by Heath (48), Thicket & Other (45) with the remainder holding 42 or less.

3.2.3 Species of conservation concern

In total 13 Red-listed and 22 Amber listed species were detected during the survey (Table 6). The highest numbers of Red- and Amber-listed species occur in Mature stands with 10 and 18 respectively, followed by Pre-thicket (eight & 16), Heath (seven & 14) and Thicket (eight & 10). The remaining primary habitats each held seven or fewer Red- listed and 10 or fewer Amber listed species.

3.2.4 Comparison with the Deer Project results

The comparison with the Deer Project was restricted to just the three growth stages covered by both surveys (Pre-thicket, Thicket and Pre-fell). For the majority of species compared, the density estimates are generally quite similar. The main differences in densities, based on singing males (Table 7a), involve species for which estimates were higher than the Deer Project. These include Blackbird (six times greater in pre-thicket) and Woodpigeon (11 times greater in pre-thicket) and lower in Great Tit (three times lower in pre-fell) and Treecreeper (10 times lower in pre-fell). For densities based on all registrations estimates (Table 7b) were higher than the Deer Project for Blue Tit (two to four times higher in the three growth stages) and Carrion Crow (three and seven times higher in Thicket and pre-fell, respectively) but lower for Siskin (four times lower in pre-fell).

3.2.5 Population estimates

Population estimates and 95% confidence intervals, based on singing males are shown in Table 5a and those for all registrations are shown in Table 5b.

4. DISCUSSION

4.1 Survey Coverage

A minimum of 3% coverage was achieved for each primary habitat; which provides a representative sample of each habitat. The high proportion of heathland covered is due to the highly aggregated distribution of this habitat, occurring at a small number of sites.

4.2 Species Richness

Although mature stands hold the highest number of species, a far higher area was covered compared to other habitats. It is not possible to calculate a standardised figure for number of species per unit area, as the relationship between number of species and area is non linear. The mature stands and their great structural diversity provide a large variety of niches for a high number of species; however, many of these will only occur at low densities. Heathland holds the second highest number of species, which is probably attributable to the structural diversity associated with these habitats and adjacent habitats. Felled areas hold the lowest number of species, which is due to the low level of structural diversity and limited vegetation growth. However, some felled areas are not planted for two or more years, which would allow considerable growth of low scrub to establish, providing breeding and feeding habitat.

4.3 Species of Conservation Concern

Of the 84 species detected during 2008, 41% are either Red- or Amber-listed species (Table 6). Although the mature stands hold the overall highest numbers of Red- and Amber-listed species the highest proportion occurs in Pre-thicket with over 61%, which includes the highest densities of Willow Warbler, Yellowhammer, Song Thrush and Turtle Dove.

In total 13 Red-listed (33% of UK total) and 22 Amber-listed species (18% of UK total) were detected during the survey (Table 6). The highest numbers of Red- and Amber-listed species occur in mature (continuous cover and wet woodland) stands with 10 and 18 respectively, followed by Pre-thicket (eight & 16), Heath (seven & 14) and Thicket (eight & 10). The remaining primary habitats each held seven or fewer Red- listed and 10 or fewer Amber-listed species.

4.4 Relative Density Estimates for Growth Stages and Habitats

The species occurring in the late successional habitats, primarily Pre-fell and mature (continuous cover and wet woodland) stands are all typically species commonly associated with woodland, with only Goldcrest Amber-listed. However the species whose highest densities occur in mid- successional (Pre-thicket, Early and Late Thicket) and early successional (Felled & Restock) habitats include many of the Red-listed (Yellowhammer, Song Thrush, Turtle Dove, Woodlark and Linnet) and Amber-listed (Dunnock & Willow Warbler) BoCC. This illustrated the high conservation importance of these early and intermediate growth stages. Species found in high densities on re-created heath but also felled/unplanted and restock include Skylark (Red-listed), Amber-listed Stonechat, Kestrel, Cuckoo and Carrion Crow, which emphasise the importance of re-created heathland to these species of conservation concern. However, the presence of high densities of Carrion Crow and Kestrel may have a detrimental influence on the breeding success of other species using this habitat.

A number of species were found in high densities in more than one habitat or growth stage, including, Chaffinch, Blackcap, Whitethroat, Garden Warbler, Carrion Crow, Greenfinch, Green Woodpecker and Jay. These are mainly generalist species, not restricted to individual habitats or successional stages, with only Green Woodpecker as an Amber-listed BoCC.

Within the mature (continuous cover and wet woodland) stands, the presences of structured understorey was important for Blue Tit, Chiffchaff, Chaffinch, Long-tailed Tit, Robin and Song

Thrush (Table 7). A positive association with the presence of large, rather than small patches or absent understorey was found for Blue Tit, Chiffchaff, Coal Tit, Jay, Marsh Tit, Robin and Wren (Table 7).

4.5 Comparison of breeding bird densities with other studies

To put some of the forest breeding bird densities into context with those encountered on farmland in Eastern England (20 tetrads surveyed in 2005-2007) (Siriwarderna *et. al*. 2008), peak mean territory densities, derived from farmland show that Yellowhammer mean densities were over twice as high as mean densities in Thetford Forest; mean 0.06 territories/ha (range 0 – 0.11 territories/ha) in farmland, compared with mean 0.14 (range 0.01 – 0.38 territories/ha) in Thetford Forest. However, densities in re-created Heath, Felled/unplanted, Restock and Thicket (Figure 6), were substantially higher (0.13-0.38). Mean densities of Chaffinch are third higher in Thetford forest, with 0.17 territories/ha (range 0.13 – 0.24 territories/ha) on farmland, compared with a mean of 0.28 territories/ha (range 0.08 – 0.56 territories/ha) in Thetford Forest.

Relative density estimates (maximum count of all individuals from single visit), for selected (typically farmland) species, as derived from the Breeding Bird Survey (BBS) (Newson *et. al.* 2008), provide broadly comparative densities for Norfolk and Suffolk (Table 8). Although the bird densities from the BBS and Thetford forest are not directly comparable, they do indicate the magnitude of relative differences. The data collected by BBS is from predominantly farmland but also includes some elements of urban, wooded and other terrestrial habitats. In all cases the peak densities (taking the highest density from all growth stages and habitats within the forest) in Thetford Forest were higher than those for the BBS. In particular, densities in the forest were much higher for Yellowhammer (four times), Willow Warbler (eight to 16 times), Turtle Dove (two to four times), Skylark (three times) and Song Thrush (five to nine times).

These comparisons indicate that particular stages of growth, within conifer plantations under rotational felling, support densities of some species of high conservation value that are substantially higher than the habitats with which they are traditionally associated, particularly farmland.

4.6 Comparison with the Deer Project Results

The Deer Project visits were approximately one month earlier than the breeding birds survey. This will have resulted in some differences in detectability between the two methodologies, particularly for species with short and early song periods. The higher densities of Blue Tit, Carrion Crow and Long-tailed Tit, as compared with the Deer Project are likely to be due to the later survey period, potentially involving a higher proportion of fledged juveniles. The higher densities of singing Woodpigeons are likely to be due to the late breeding season (late summer/autumn) of this species and associated higher song activity. Lower densities of singing Coal Tit, Dunnock, Great Tit and Treecreeper are all probably due to decreased activity toward the end of their respective song periods during the later timing of the survey.

There are also methodological differences in that the Deer Project transects run within a block of similar age habitat, whereas in the 2008 transects often followed rides, paths and track ways, which often have different habitats on either side. However, by controlling for the area of each habitat surveyed the densities calculated will be comparable.

The main differences will be in the form of observer effects and vegetation structure/composition. As the two surveys did not take place at the same spatial scale and all blocks are not represented in each, most of the big differences in the densities detected will also be due to the structural nature of vegetation. Also the Thicket growth stage as defined by the Deer Project and adopted by the 2008 survey encompasses the growing years 10 – 19, however, for the bird monitoring the habitat selection was restricted to 10 – 15 growing years. Again this will lead to some differences in vegetation structure and associated bird densities between the two surveys.

4.7 Limitations

The location of individual registrations in relation to sub compartment boundaries is liable to a degree of error, however this was minimised by displaying the boundaries during plotting in GIS. It was not possible to model density for many of the rare and scarce species due to insufficient data (typically species with less than 30 data points). Also, nocturnal species (particularly Tawny Owl, Long-eared Owl and Nightjar) are not covered by this survey method.

Both the timings of the 2008 survey and the Deer Project are too late to cover the peak song period for some of the early breeding species, such as Crossbill, Woodlark, Mistle Thrush, Lesser Spotted Woodpecker, Willow Tit and Marsh Tit.

Modelling of bird densities are limited by the available data. Ideally, at least thirty data points per growth stage or habitat category are required to adequately model density.

Bird population estimates for Thetford Forest Park are based on an extrapolation of density estimates from a relatively small sample of the forest. Even though controlling for habitat structure within the surveyed area has refined the density estimates, there is no structural data for the entire forest. Therefore, bird densities will deviate from estimated values depending on the precise structure within the same growth stage or habitat. These **population estimates should only be treated as indicative** and viewed in the context of the 95% confidence intervals.

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Table 1 Definition of forest growth stages and habitats, derived form the Forestry Commission sub-compartment database.

Primary growth stage/ Habitat type	Definition	Forest successional category	Age (growing years)
Heath	Heathland created from forest.	Open	N/a
Felled/Unplanted	Forest	Open	0
Restock	Forest	Early	0 - 4
Pre-thicket	Forest	Early	5 - 9
Early Thicket	Forest	Mid	10-14
Late Thicket	Forest	Mid	15 - 19
Pre-fell	Forest	Late	20 - 45
Continuous Cover	Forest	Late	> 20
Wet Woodland	Forest	Late	> 20

Table 2 Number of 1-km survey squares covered in each forest block.

Block	2008
Croxton	1
Diddlington	0
Elveden	3
Feltwell	3
Harling	3
High Lodge	10*
Hockham	3
Kings	5
Lynford	10*
Mildenhall	3
Mundford	3
Roudham/Bridgham	1
Swaffham	3
Total	45

* Three 1-km survey squares have transects which straddle two blocks.

Table 3 (part 1) Summary of all species encountered, excluding flight only records, and Maximum counts (ie highest single visit count), for singing and all individuals from all records and distance band up to 75 m. Species in bold are Red-listed in BoCC; species in italics are Amber-listed.

Species	Total records	Max count of All Males	Max count of All birds	Total records within 75m	Max count of Males within 75m	Max count of All birds within 75m
Blackbird	388	101	174	318	69	139
Blackcap	520	211	236	428	169	191
Black-headed Gull	2	0	0	0	0	0
Blue Tit	750	34	350	644	30	300
Bullfinch	**40**	**6**	**20**	**38**	**6**	**19**
Buzzard	2	0	1	0	0	0
Carrion Crow	680	58	263	418	31	156
Chaffinch	1730	514	778	1388	390	621
Chiffchaff	590	261	276	440	192	204
Coal Tit	1114	142	501	974	124	434
Collared Dove	6	0	0	6	0	0
Coot	2	0	1	2	0	1
Cormorant	8	0	1	4	0	1
Crossbill	54	0	21	50	0	19
Cuckoo	*50*	*10*	*20*	*8*	*2*	*4*
Curlew	16	1	6	6	1	3
Dunnock	*224*	*49*	*105*	*190*	*36*	*88*
Firecrest	*32*	*2*	*13*	*30*	*1*	*12*
Garden Warbler	120	55	56	100	45	46
Goldcrest	*894*	*168*	*397*	*828*	*153*	*365*
Goldfinch	58	4	22	50	3	20
Goosander	16	1	3	16	1	3
Great Spotted Woodpecker	158	4	73	96	2	43
Great Tit	814	98	360	698	83	306
Green Woodpecker	*230*	*20*	*98*	*140*	*15*	*59*
Greenfinch	82	11	31	74	9	27
Grey Heron	12	0	4	10	0	3
Grey Partridge	**2**	**0**	**0**	**2**	**0**	**0**
Grey Wagtail	*8*	*1*	*3*	*6*	*0*	*2*
Hobby	12	0	5	8	0	4
House Martin	26	0	13	26	0	13
Jackdaw	70	1	20	26	0	4
Jay	310	0	140	244	0	108
Kestrel	*24*	*3*	*10*	*12*	*2*	*6*
Kingfisher	2	0	1	2	0	1
Lapwing	14	0	0	6	0	0
Lesser Black-backed Gull	56	0	0	0	0	0
Lesser Redpoll	*4*	*1*	*1*	*4*	*1*	*1*
Lesser Whitethroat	2	1	1	0	0	0
Linnet	**172**	**25**	**58**	**150**	**18**	**48**
Little Grebe	2	1	1	0	0	0
Long-tailed Tit	526	21	258	450	18	220
Magpie	84	0	36	62	0	26
Mallard	42	5	17	28	4	14
Marsh Tit	**88**	**3**	**43**	**68**	**2**	**33**

Table 3 (part 2) Summary of all species encountered, excluding flight only records, and Maximum counts (ie highest single visit count), for singing and all individuals from all records and distance band up to 75 m. Species in bold are Red-listed in BoCC; species in italics are Amber-listed.

Species	Total records	Max count of All Males	Max count of All birds	Total records within 75m	Max count of Males within 75m	Max count of All birds within 75m
Meadow Pipit	*4*	*0*	*1*	*4*	*0*	*1*
Mistle Thrush	*58*	*11*	*25*	*38*	*5*	*19*
Moorhen	26	0	13	24	0	12
Mute Swan	*14*	*1*	*7*	*14*	*1*	*7*
Nightjar	**2**	**0**	**1**	**2**	**0**	**1**
Nuthatch	36	7	17	20	5	10
Pheasant	136	6	64	66	3	31
Pied Wagtail	8	0	1	8	0	1
Red Kite	2	0	1	0	0	0
Red-legged Partridge	58	2	29	48	1	24
Redstart	*6*	*2*	*3*	*6*	*2*	*3*
Reed Bunting	**2**	**1**	**1**	**2**	**1**	**1**
Reed Warbler	2	1	1	2	1	1
Robin	1288	477	583	1106	402	497
Rook	36	0	0	36	0	0
Sedge Warbler	2	1	1	0	0	0
Shelduck	2	0	0	0	0	0
Siskin	36	3	16	32	2	14
Skylark	**334**	**113**	**127**	**114**	**36**	**48**
Song Thrush	**280**	**97**	**125**	**158**	**45**	**67**
Sparrowhawk	14	1	1	12	1	1
Spotted Flycatcher	**10**	**1**	**5**	**10**	**1**	**5**
Starling	**6**	**0**	**2**	**2**	**0**	**0**
Stock Dove	*72*	*8*	*20*	*52*	*4*	*16*
Stonechat	*60*	*15*	*28*	*48*	*12*	*23*
Swallow	*34*	*0*	*10*	*30*	*0*	*10*
Swift	74	0	11	26	0	11
Tawny Owl	6	0	3	4	0	2
Tree Pipit	*392*	*140*	*163*	*196*	*64*	*83*
Treecreeper	116	13	54	108	13	50
Turtle Dove	**60**	**18**	**26**	**24**	**6**	**11**
Whitethroat	288	107	137	222	81	105
Willow Tit	**6**	**3**	**3**	**6**	**3**	**3**
Willow Warbler	*476*	*190*	*198*	*324*	*129*	*135*
Wood Pigeon	1644	335	679	1258	214	517
Woodcock	4	0	1	4	0	1
Woodlark	**144**	**29**	**63**	**100**	**13**	**45**
Wren	2108	735	899	1710	578	726
Yellowhammer	**576**	**177**	**245**	**368**	**103**	**159**

Table 4 Area of each primary habitat in Thetford Forest Park and area surveyed.

Growth stage/ habitat class	Total Area (ha)	% Area surveyed within 75m buffer 2008	Deer Project (2007&2008)
Heath	303.6	24.7%	-
Felled	512.2	4.2%	-
Restock	1114.9	8.6%	-
Pre-Thicket	1144.0	4.0%	*29.2%
Thicket (Early & Late)	3180.5	4.8%	*11.4%
Pre-fell	6031.2	3.0%	*4.2%
Continuous Cover & Wet woodland	5494.0	6.6%	-
Total	**18972.9**	**5.3%**	**-**

* Note some Deer Project plots were surveyed in both years so the actual area covered will be less.

Table 5 Breeding population estimates and 95% confidence intervals for Thetford Forest Park. Species in bold are Red-listed in BoCC; species in italics are Amber-listed.

a) Males

Name	Heath	Felled	Restock	Pre-Thicket	Thicket	Pre-fell	Continuous Cover and Wet Woodland	Total	95% Confidence Intervals
Blackbird	0	11	0	55	137	72	236	543	200-1541
Blackcap	0	55	28	162	353	483	1058	2261	1100-4789
Bullfinch	**0**	**0**	**0**	**0**	**0**	**38**	**38**	**76**	**13-514**
Chiffchaff	3	20	38	195	648	763	1031	2869	1532-5601
Chaffinch	18	51	104	183	1061	1335	2510	5538	3485-8971
Coal Tit	0	14	0	54	168	690	704	1686	648-4561
Dunnock	*9*	*79*	*29*	*138*	*202*	*45*	*70*	*649*	*240-1975*
Goldcrest	*0*	*14*	*18*	*46*	*347*	*523*	*1087*	*2060*	*1025-4320*
Greenfinch	0	12	0	0	0	51	9	98	17-632
Great Tit	2	6	12	0	63	152	273	547	173-1806
Garden Warbler	6	0	9	48	150	116	173	539	193-1598
Linnet	**22**	**0**	**23**	**87**	**0**	**0**	**0**	**152**	**40-626**
Mistle Thrush	*0*	*0*	*0*	*0*	*0*	*47*	*55*	*102*	*24-503*
Marsh Tit	**0**	**0**	**0**	**0**	**0**	**99**	**0**	**99**	**21-466**
Nuthatch	0	0	0	0	0	0	52	52	12-221
Robin	4	71	86	315	1308	2137	2275	6448	4039-10432
Skylark	**77**	**7**	**41**	**0**	**0**	**0**	**17**	**174**	**52-673**
Stonechat	*21*	*28*	*63*	*0*	*0*	*0*	*0*	*134*	*38-585*
Siskin	0	0	0	0	0	0	19	19	2-149
Song Thrush	**0**	**0**	**10**	**136**	**175**	**251**	**231**	**821**	**390-1854**
Treecreeper	0	0	0	0	0	64	58	133	28-670
Turtle Dove	**0**	**0**	**0**	**21**	**23**	**41**	**0**	**85**	**16-457**
Tree Pipit	*27*	*116*	*222*	*146*	*20*	*0*	*14*	*581*	*232-1633*
Whitethroat	29	0	152	278	104	136	271	1207	591-2603
Woodlark	**9**	**31**	**36**	**0**	**31**	**0**	**23**	**130**	**35-504**
Wood Pigeon	3	12	6	23	366	603	902	1973	717-5584
Wren	26	87	240	482	1289	2633	2953	7994	4481-14346
Willow Warbler	*14*	*78*	*60*	*346*	*546*	*138*	*159*	*1391*	*575-3471*
Yellowhammer	**80**	**141**	**189**	**520**	**374**	**140**	**55**	**1706**	**925-3339**

Table 5 Breeding population estimates and 95% confidence intervals for Thetford Forest Park. Species in bold are Red-listed in BoCC; species in italics are Amber-listed.

b) all registrations **(NOTE these figures relate to individuals, not pairs)**

Name	Heath	Felled	Restock	Pre-Thicket	Thicket	Pre-fell	Continuous Cover and Wet Woodland	Total	95% confidence Intervals
Blue Tit	16	40	115	140	680	1241	2212	**4644**	2874-7682
Carrion Crow	90	38	130	79	408	457	758	**2112**	1075-4251
Cuckoo	**0**	**0**	**20**	**0**	**0**	**0**	**26**	**46**	**11-210**
Crossbill	61	5	0	0	0	0	33	**99**	13-803
Firecrest	*0*	*0*	*0*	*0*	*11*	*11*	*14*	***35***	*3-496*
G. Woodpecker	*12*	*19*	*44*	*80*	*122*	*47*	*331*	***727***	*312-2104*
Goldfinch	*7*	*4*	*28*	*0*	*9*	*24*	*21*	***131***	*22-904*
Greenfinch	0	35	0	149	22	155	101	**496**	126-2175
Great Spotted Woodpecker	0	0	0	0	79	134	340	**573**	246-1508
Jay	10	7	8	66	246	399	484	**1246**	529-3064
Kestrel	*3*	*87*	*0*	*17*	*0*	*0*	*0*	***118***	*17-893*
Long-tailed Tit	24	18	26	92	786	704	1945	**3681**	2008-7044
Magpie	15	10	22	0	67	51	44	**256**	57-1230
R. L. Partridge	19	0	32	0	145	0	36	**338**	97-1225
Stock Dove	*13*	*0*	*0*	*0*	*0*	*32*	*84*	***133***	*29-742*
Siskin	0	0	0	21	37	0	150	**208**	73-707

Table 6 Species richness within primary habitats.

Growth stage/ habitat class	Total species	Red-listed species	Amber-listed species	Sampled area (ha) within 75m buffer
Heath	48	7	14	74.9
Felled	36	6	9	21.3
Restock	42	6	10	95.7
Pre-Thicket	39	8	16	45.2
Thicket (Early and Late)	45	8	10	152.6
Pre-fell	42	7	9	179.8
Continuous Cover & Wet woodland	62	10	18	360.8
Total	**84**	**13**	**22**	**1008.8**

Table 7 Summary of associations between species and habitat structure derived from mixed models. Variables with significant (P <0.05), associations are represented by an X. Model fit values close, or equal, to 1 indicate Good models. Species in bold are Red-listed in BoCC; species in italics are Amber-listed.

Species	Count type	Distance band	Growth stage	Forest block	Stand structure	Understorey distribution	Model Fit (ChiS_DF)
Blackbird	Singing	75	X	-	-	-	0.64
Blackcap	Singing	50	X	-	-	-	1.08
Bullfinch	All	50	X	-	-	-	0.52
Blue Tit	All	50	-	X	X	X	1.20
Carrion Crow	All	50	X	-	-	-	1.00
Chiffchaff	Singing	50	X	X	X	X	1.05
Chaffinch	Singing	50	X	-	X	-	0.88
Coal Tit	Singing	50	X	-	-	X	0.72
Dunnock	Singing	50	X	-	-	-	1.08
Green Woodpecker	All	75	X	-	-	-	1.23
Goldcrest	Singing	50	X	-	-	-	0.94
Great Spotted Woodpecker	All	50	X	-	-	-	0.95
Garden Warbler	Singing	50	X	-	-	-	0.62
Jay	All	50	X	-	-	X	1.02
Kestrel	All	50	X	-	-	-	0.75
Linnet	All	50	X	-	-	-	1.15
Long-tailed Tit	All	50	X	-	X	-	2.57
Mistle Thrush	All	75	X	-	-	-	1.62
Marsh Tit	All	50	X	-	-	X	0.61
Robin	Singing	50	X	-	X	X	0.80
Skylark	All	75	X	-	-	-	1.00
Stonechat	Singing	50	X	-	-	-	0.60
Siskin	All	50	X	-	-	-	0.59
Song Thrush	Singing	50	X	-	X	-	0.62
Treecreeper	All	50	X	-	-	-	0.67
Turtle Dove	All	75	X	-	-	-	0.80
Tree Pipit	Singing	50	X	-	-	-	0.95
Whitethroat	Singing	50	X	-	-	-	1.21
Woodlark	All	75	X	-	-	-	1.25
Wood Pigeon	Singing	50	X	X	-	-	0.71
Wren	Singing	50	X	-	-	X	0.87
Willow Warbler	Singing	50	X	-	-	-	0.91
Yellowhammer	Singing	75	X	-	-	-	0.95

Table 7a Comparative bird density estimates, with confidence intervals (ci's), for Pre-Thicket, Thicket and Pre-fell growth stages, derived from GLMM's using Deer Project (2007 & 2008) and breeding birds monitoring (2008) data. Species in bold are Red-listed in BoCC; species in italics are Amber-listed.

6a) singing males

			Pre-thicket				**Thicket**				**Pre-Fell**			
			Deer Project		2008		Deer Project		2008		Deer Project		2008	
Species	**Width**	**Model**	**Estimate**	**ci's**	**Estimate**	**ci's**	**Estimate**	**ci's**	**Estimate**	**ci's**	**Estimate**	**ci's**	**Estimate**	**ci's**
Blackbird	75	GS & Block	0.01	0 - 0.03	0.06	0.02 - 0.18	0.02	0.01 - 0.04	0.05	0.02 - 0.12	0.03	0.02 - 0.07	0.05	0.02 - 0.11
Blackcap	50	GS & Block	0.06	0.04 - 0.11	0.16	0.06 - 0.37	0.19	0.12 - 0.29	0.15	0.06 - 0.25	0.3	0.2 - 0.47	0.23	0.11 - 0.36
Chaffinch	50	GS & Block	0.16	0.11 - 0.23	0.15	0.07 - 0.33	0.37	0.28 - 0.5	0.33	0.21 - 0.53	0.54	0.41 - 0.73	0.45	0.30 - 0.68
Chiffchaff	50	GS & Block	0.14	0.09 - 0.23	0.18	0.09 - 0.41	0.28	0.18 - 0.42	0.24	0.13 - 0.37	0.31	0.2 - 0.48	0.21	0.13 - 0.32
Coal Tit	50	GS & Block	0.05	0.03 - 0.1	0.06	0.02 - 0.23	0.27	0.17 - 0.41	0.06	0.03 - 0.15	0.44	0.29 - 0.67	0.15	0.08 - 0.30
Cuckoo	75	GS & Block	0.01	0 - 0.06	0	n/a	0.01	0 - 0.07	0	n/a	0.01	0 - 0.12	<0.01	0 - 0.2
Dunnock	*50*	*GS & Block*	*0.12*	*0.05 - 0.26*	*0.07*	*0.04 - 0.29*	*0.07*	*0.03 - 0.16*	*0.06*	*0.03 - 0.13*	*0.06*	*0.03 - 0.15*	*0.05*	*0 - 0.03*
Garden Warbler	50	GS & Block	0.07	0.04 - 0.11	0.05	0.01 - 0.20	0.06	0.03 - 0.1	0.06	0.02 - 0.14	0.03	0.01 - 0.06	0.03	0.01 - 0.08
Goldcrest	*50*	*GS & Block*	*0.06*	*0.02 - 0.16*	*0.12*	*0.01 - 0.13*	*0.29*	*0.13 - 0.68*	*0.31*	*0.04 - 0.21*	*0.43*	*0.18 - 0.99*	*0.31*	*0.09 - 0.35*
Great Tit	50	GS & Block	0.02	0.01 - 0.07	0	n/a	0.04	0.01 - 0.1	0.02	0.01 - 0.08	0.15	0.06 - 0.36	0.06	0.02 - 0.15
Robin	50	GS & Block	0.2	0.13 - 0.3	0.40	0.15 - 0.51	0.51	0.35 - 0.74	0.50	0.26 - 0.61	0.58	0.39 - 0.85	0.52	0.28 - 0.60
Song Thrush	**50**	**GS &Block**	**0.02**	**0 - 0.09**	**0.08**	**0.01 - 0.24**	**0.08**	**0.02 - 0.32**	**0.10**	**0.02 - 0.11**	**0.03**	**0.01 - 0.13**	**0.05**	**0.02 - 0.07**
Tree Pipit	*50*	*GS & Block*	*0.15*	*0.12 - 0.3*	*0.21*	*0.09 - 0.39*	*0.04*	*0.02 - 0.08*	*0.03*	*0 - 0.06*	*0*	*n/a*	*0.01*	*0 - 0.02*
Treecreeper	50	GS only	0	n/a	0	n/a	0.01	0 - 0.04	0	n/a	0.11	0.03 - 0.33	0.01	0 - 0.04
Whitethroat	50	GS & Block	0.37	0.19 - 0.7	0.30	0.11 - 0.55	0.1	0.05 - 0.2	0.05	0.01 - 0.10	<0.01	0 - 0.03	0.05	0.03 - 0.10
Willow Warbler	*50*	*GS & Block*	*0.32*	*0.2 - 0.52*	*0.33*	*0.13 - 0.79*	*0.23*	*0.14 - 0.37*	*0.19*	*0.08 - 0.44*	*0.01*	*0 - 0.03*	*0.03*	*0.01 - 0.07*
Woodpigeon	50	GS & Block	0.02	0 - 0.09	0.23	0 - 0.13	0.16	0.04 - 0.63	0.39	0.05 - 0.28	0.21	0.05 - 0.85	0.58	0.08 - 0.36
Wren	50	GS & Block	0.31	0.25 - 0.4	0.49	0.23 - 0.83	0.46	0.37 - 0.56	0.65	0.25 - 0.75	0.65	0.52 - 0.8	0.73	0.34 - 0.95
Yellowhammer	**75**	**GS &Block**	**0.16**	**0.06 - 0.39**	**0.38**	**0.25 - 0.60**	**0.10**	**0.04 - 0.24**	**0.10**	**0.06 - 0.16**	**<0.01**	**0 - 0.02**	**0.01**	**0 - 0.03**

Table 7b Comparative bird density estimates, with confidence intervals (ci's), for Pre-Thicket, Thicket and Mature growth stages, derived from GLMM's using Deer Project (2007 & 2008) and breeding birds monitoring (2008) data. Species in bold are Red-listed in BoCC; species in italics are Amber-listed.

6b) total registrations			**Pre-thicket**				**Thicket**				**Pre-Fell**			
			Deer Project		2008		Deer Project		2008		Deer Project		2008	
Species	**Width**	**Model**	**Estimate**	**ci's**	**Estimate**	**ci's**	**Estimate**	**ci's**	**Estimate**	**ci's**	**Estimate**	**ci's**	**Estimate**	**ci's**
Blue Tit	50	GS & Block	0.03	0.01 - 0.09	0.13	0.05 - 0.31	0.07	0.03 - 0.19	0.21	0.12 - 0.36	0.26	0.1 - 0.66	0.40	0.26 - 0.61
Bullfinch	**50**	**GS only**	**<0.01**	**0 - 0.03**	**0**	**n/a**	**0.03**	**0.01 - 0.1**	**<0.01**	**0 - 0.04**	**0.02**	**0.01 - 0.09**	**0.1**	**0 - 0.05**
Carrion Crow	50	GS & Block	0.03	0 - 0.24	0.05	0.01 - 0.20	0.02	0 - 0.17	0.14	0.06 - 0.31	0.04	0 - 0.33	0.13	0.06 - 0.26
G. S. Woodpecker	50	GS & Block	<0.01	0 - 0.02	0	N/a	0.02	0.01 - 0.05	0.02	<0.01 - 0.08	0.04	0.02 - 0.1	0.06	0.03 - 0.12
G. Woodpecker	*75*	*GS & Block*	*0.03*	*0.01 - 0.12*	*0.04*	*0.01 - .014*	*0.04*	*0.01 - 0.18*	*0.03*	*0.01 - 0.07*	*0.02*	*0 - 0.09*	*0.06*	*0.03 - 0.11*
Jay	50	GS & Block	0.02	0.01 - 0.04	0.05	0.02 - 0.18	0.05	0.02 - 0.09	0.07	0.03 - 0.18	0.03	0.02 - 0.07	0.09	0.04 - 0.20
Linnet	*50*	*GS only*	*0.09*	*0.03 - 0.27*	*0.09*	*0.02 - 0.42*	*0.01*	*0 - 0.06*	*<0.01*	*0 - 0.04*	*0*	*n/a*	*<0.01*	*0 - 0.02*
Long-tailed Tit	50	GS & Block	0.11	0.06 - 0.19	0.08	0.03 - 0.25	0.17	0.1 - 0.3	0.25	0.14 - 0.46	0.19	0.11 - 0.34	0.35	0.21 - 0.60
Marsh Tit	**50**	**GS only**	**0**	**n/a**	**0**	**n/a**	**0.02**	**0.01 - 0.04**	**<0.01**	**0 - 0.03**	**0.07**	**0.04 - 0.14**	**0.03**	**0.01 - 0.09**
Pheasant	50	GS & Block	0.1	0.05 - 0.21	0	n/a	0.06	0.03 - 0.14	0.05	0.01 - 0.18	0.02	0.01 - 0.05	0.03	0.01 - 0.10
R. L. Partridge	50	GS only	0.01	0 - 0.04	0	n/a	0.01	0 - 0.04	0.05	0.02 - 0.14	0.01	0 - 0.04	0.01	0 - 0.03
Siskin	50	GS only	0.02	0 - 0.04	0.02	0 - 0.15	0.03	0 - 0.06	0.01	0 - 0.06	0.12	0.02 - 0.21	0.03	0.01 - 0.07
Skylark	**75**	**GS only**	**0.02**	**0 - 0.12**	**0**	**n/a**	**0.01**	**0 - 0.06**	**0.01**	**0 - 0.02**	**<0.01**	**0 - 0.03**	**<0.01**	**0 - 0.05**
Woodlark	**75**	**GS & Block**	**0.03**	**0.01 - 0.11**	**0.01**	**0 - 0.11**	**<0.01**	**0 - 0.02**	**0.01**	**0 - 0.05**	**<0.01**	**0 - 0.02**	**<0.01**	**0 - 0.03**

Table 8 Densities estimates (individuals per hectare) and confidence intervals (ci's), of selected non-forest species, as derived from the Breeding Bird Survey (BBS) for Norfolk (n=66 1-km squares) and Suffolk (n=53 1-km squares) in 2006.

Species	Norfolk		Suffolk		Thetford Forest
	Estimate	Ci's	Estimate	Ci's	Maximum density
Chaffinch	0.807	0.660 – 0.954	0.723	0.572 - 0.873	1.111*
Dunnock	0.255	0.186 – 0.324	0.253	0.178 - 0.327	0.326*
Green Woodpecker	0.008	0.003 – 0.013	0.017	0.009 - 0.026	0.075
Linnet	0.088	0.032 – 0.143	0.066	0.014 - 0.118	0.160
Skylark	0.103	0.061 – 0.145	0.078	0.039 - 0.118	0.353
Song Thrush	0.050	0.031 – 0.069	0.028	0.012 - 0.043	0.263*
Turtle Dove	0.011	0.003 – 0.018	0.018	0.008 - 0.028	0.040
Common Whitethroat	0.219	0.156 – 0.282	0.219	0.151 - 0.287	0.241*
Willow Warbler	0.041	0.016 – 0.067	0.021	0.002 - 0.041	0.339*
Yellowhammer	0.160	0.099 – 0.222	0.181	0.110 - 0.252	0.762*

* Densities based on singing males only have been doubled to provide an approximate equivalent density estimate.

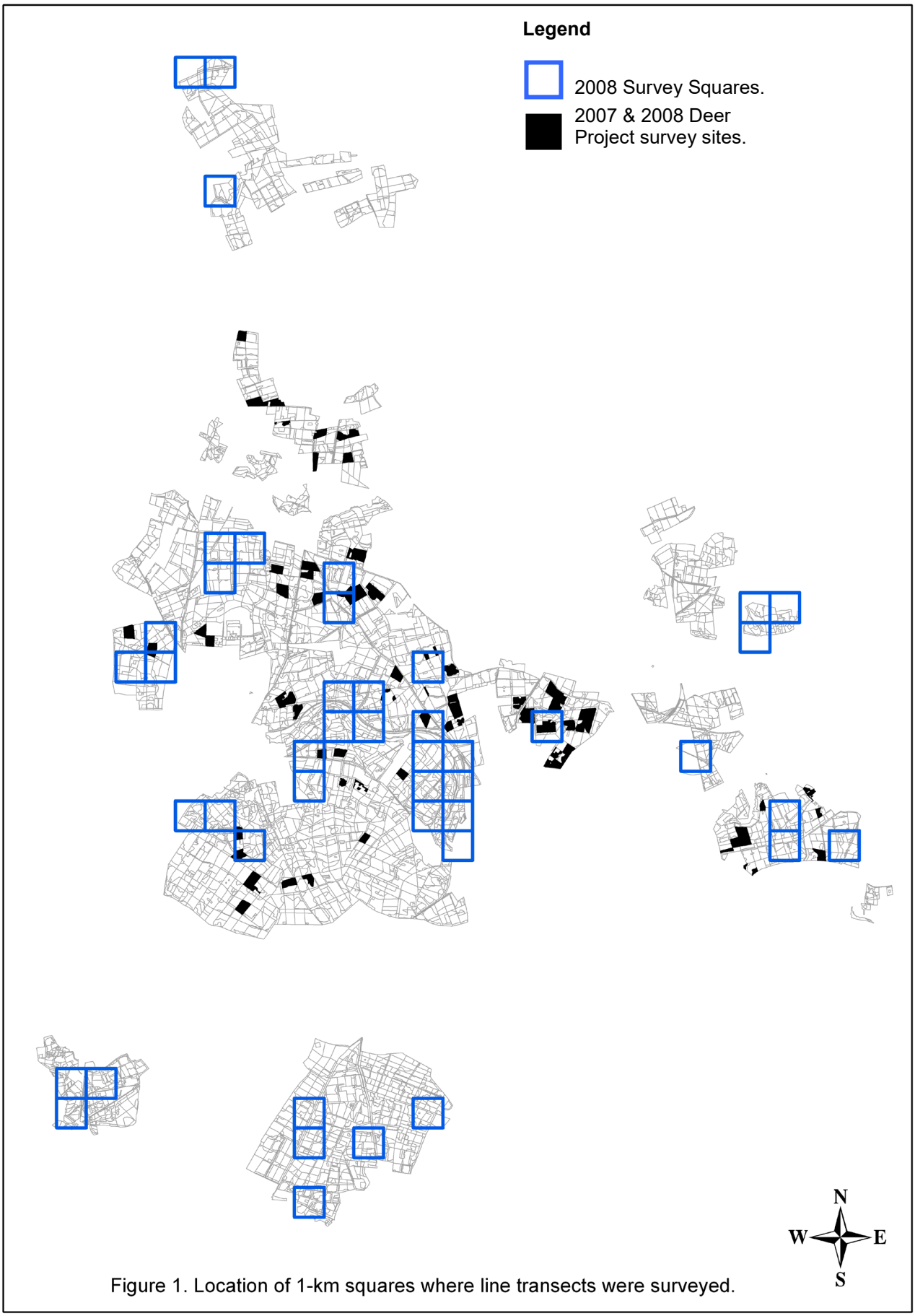


Figure 1. Location of 1-km squares where line transects were surveyed.

Figure 2a-f Relative density estimates (from maximum single count per Visit), across growth stages and habitats.

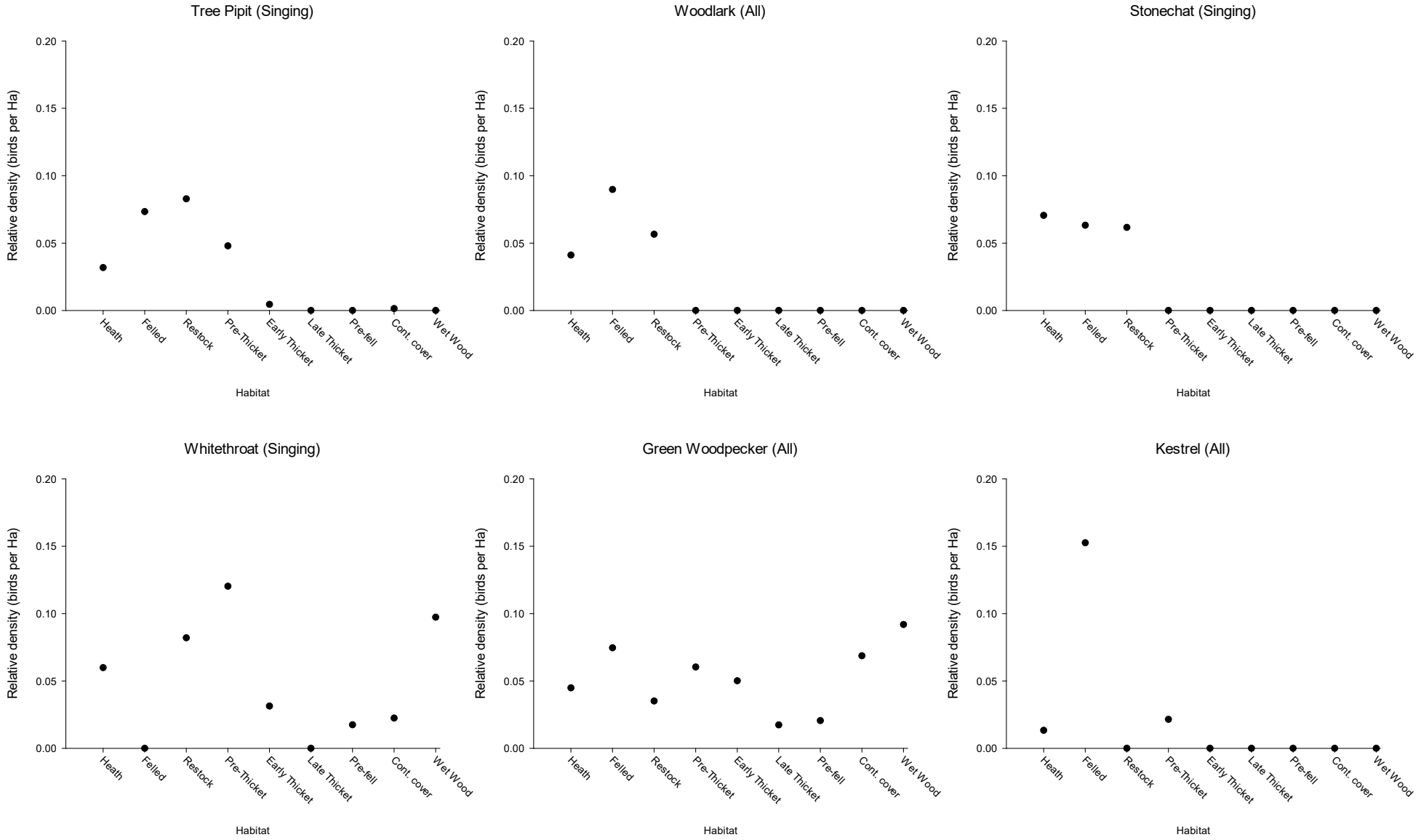


Figure 3a-d Relative density estimates (from maximum single count of, singing or all, individuals per Visit), across growth stages and habitats.

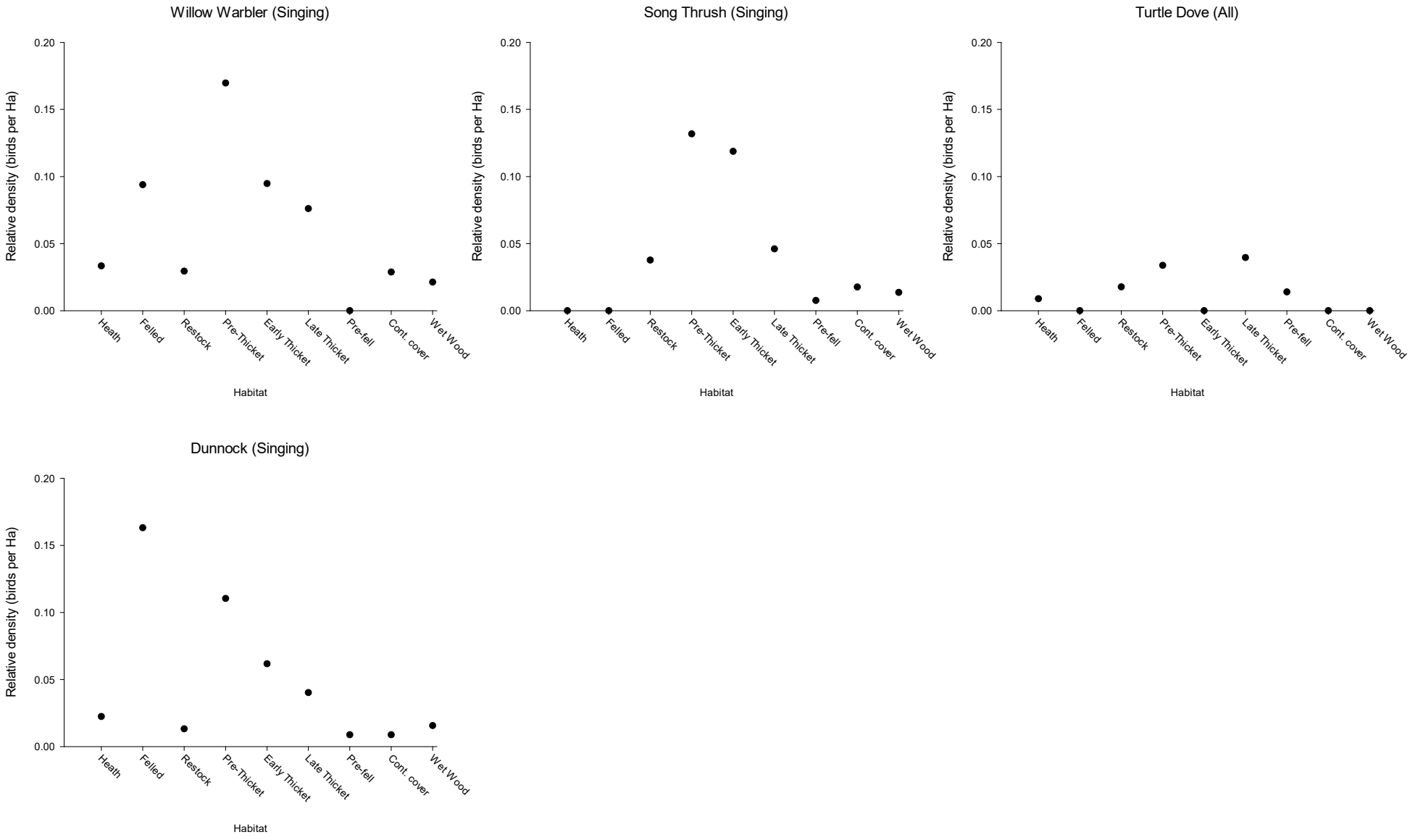


Figure 4a-f Relative density estimates (from maximum single count of, singing or all, individuals per Visit), across growth stages and habitats.

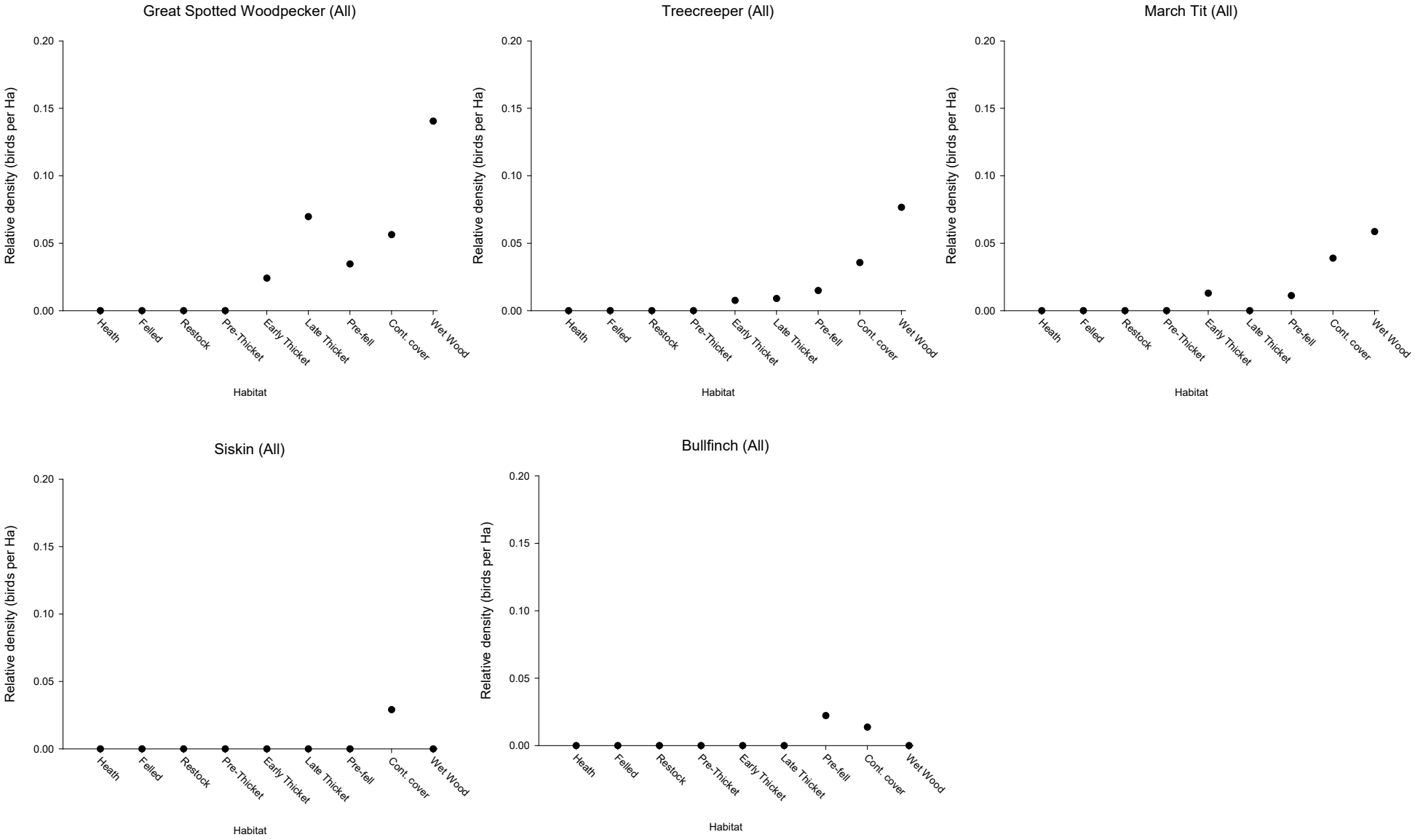


Figure 5a-f Relative density estimates (from maximum single count of, singing or all, individuals per Visit), across growth stages and habitats.

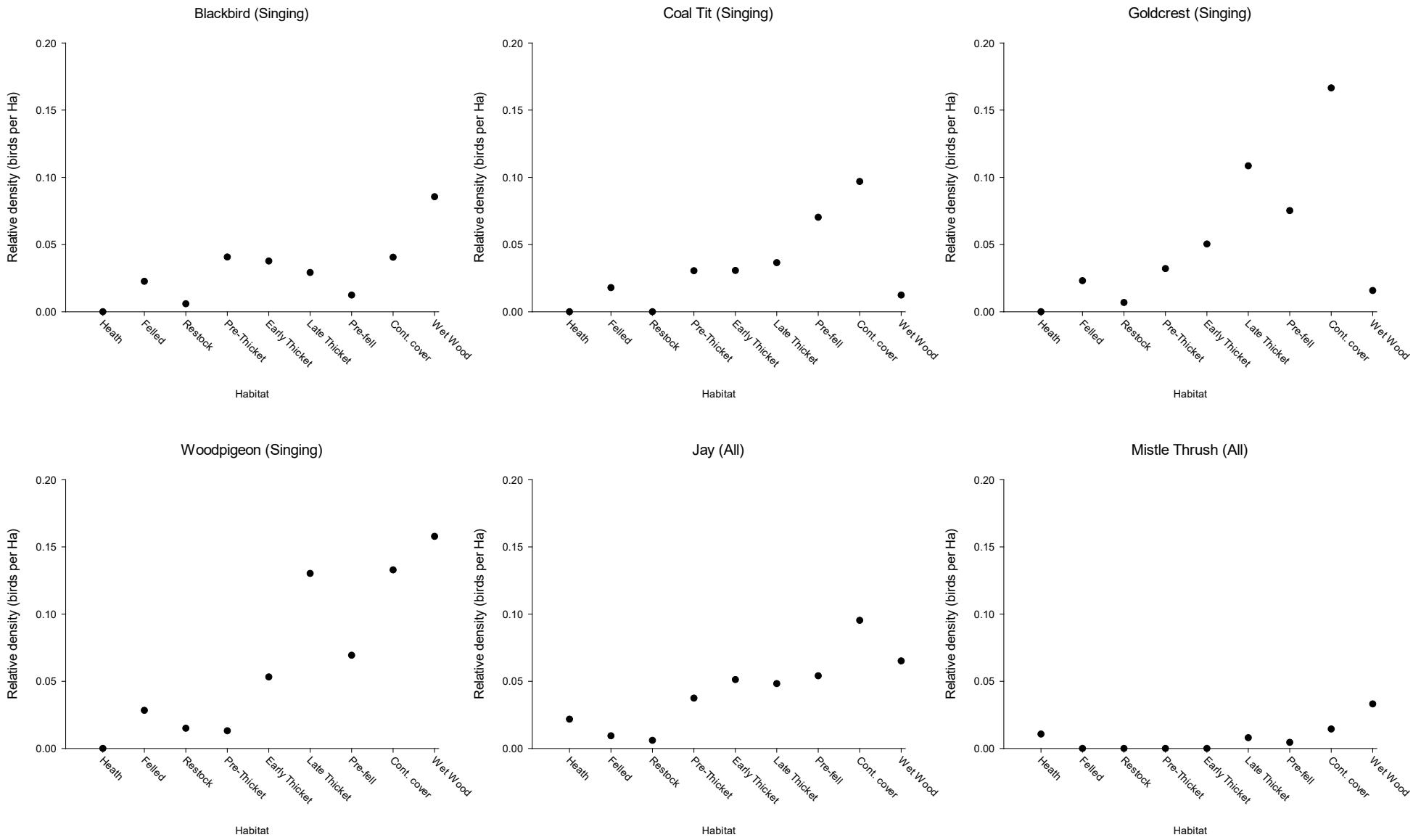


Figure 6a-f Relative density estimates (from maximum single count of, singing or all, individuals per Visit), across growth stages and habitats.

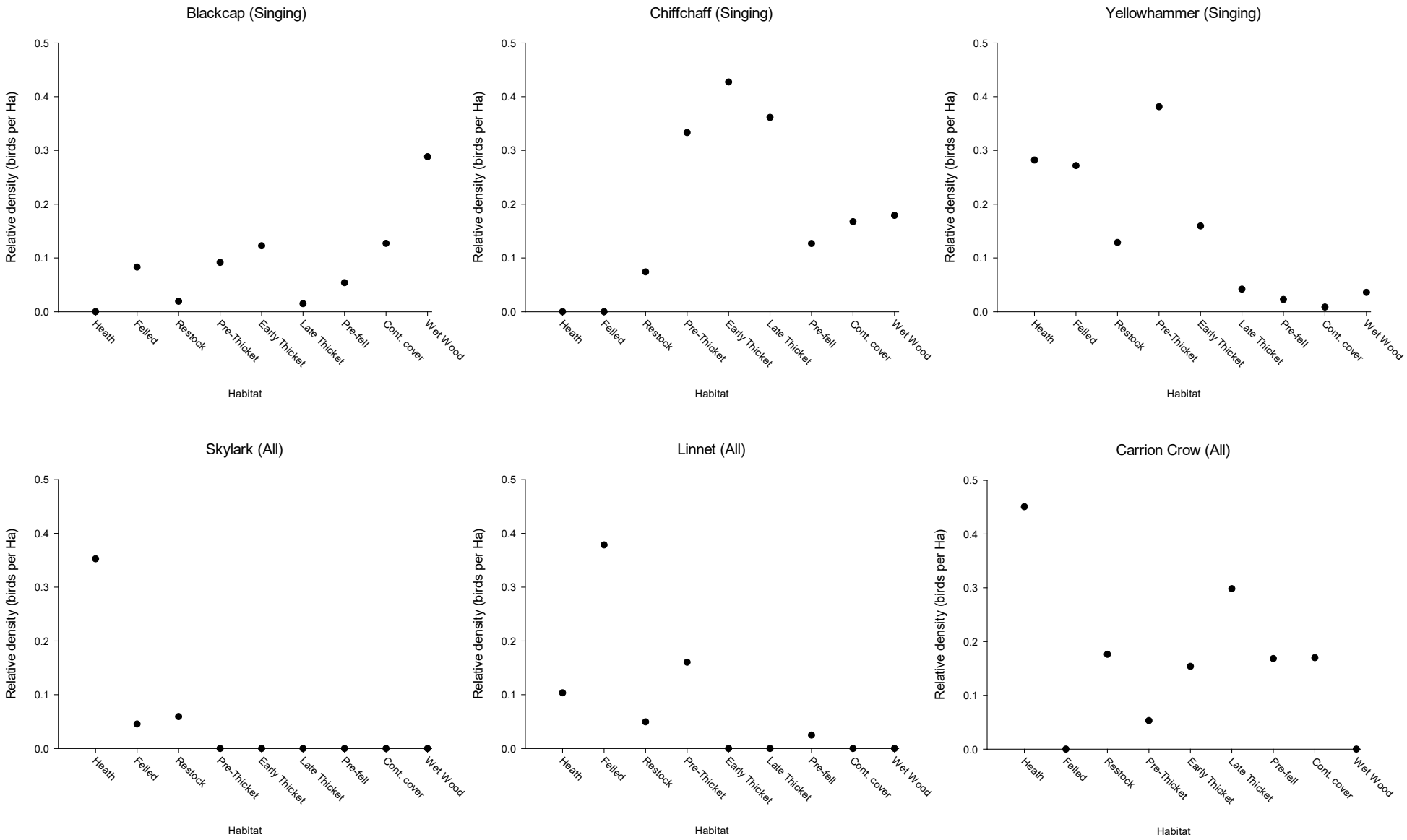
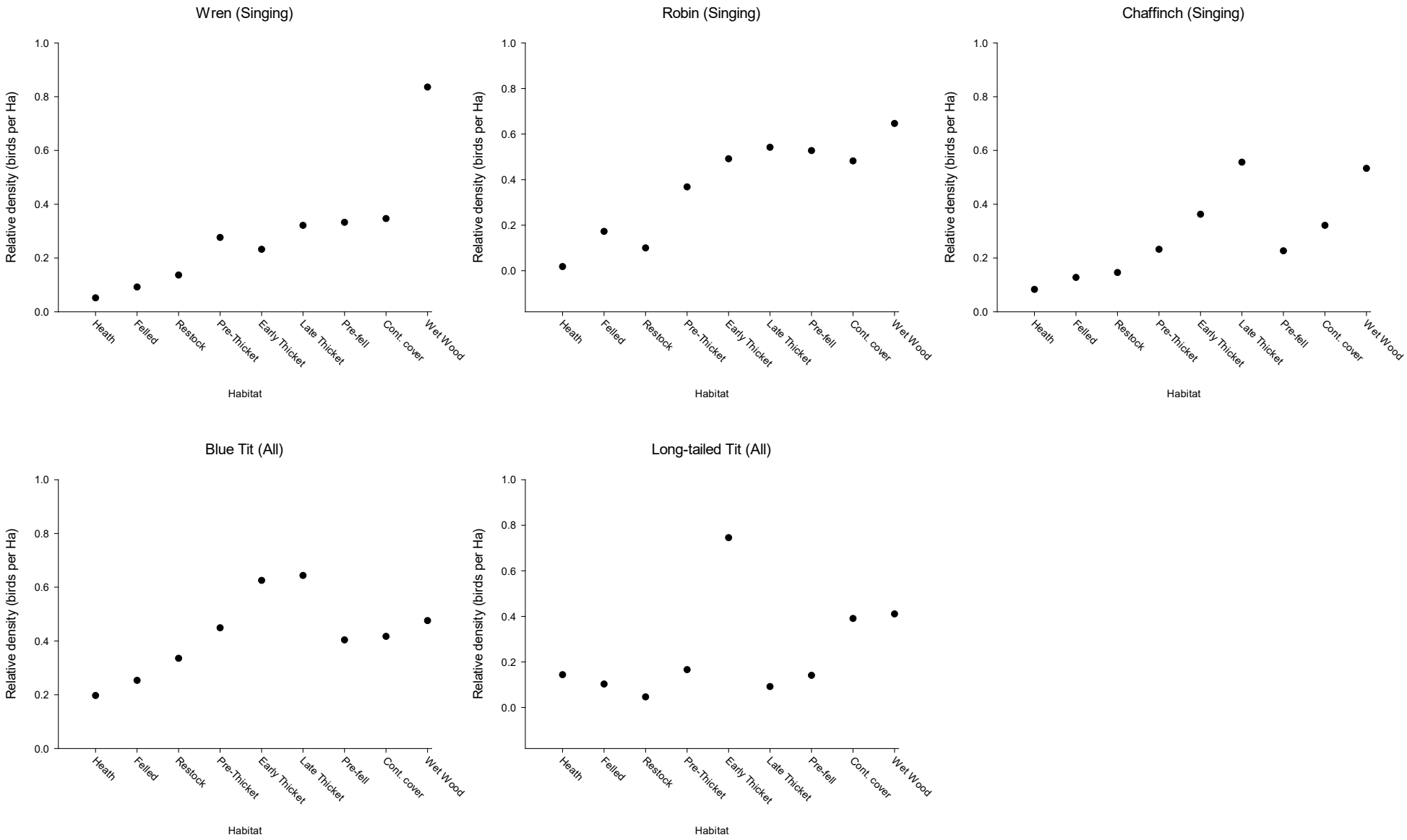


Figure 7a-e Relative density estimates (from maximum single count of, singing or all, individuals per Visit), across growth stages and habitats.



Appendix 1a Species Lists and relative abundance for each growth stage/ habitat class (all registrations). Species in bold are Red-listed in BoCC; species in italics are Amber-listed.

Felled/Unplanted Species	%	Restock Species	%	Pre-Thicket Species	%
Yellowhammer	**13.34**	*Tree Pipit*	*13.21*	*Willow Warbler*	*12.75*
Tree Pipit	*13.00*	**Yellowhammer**	**10.60**	**Yellowhammer**	**10.15**
Woodlark	**7.80**	Wren	8.18	Wren	9.68
Pheasant	7.28	Wood Pigeon	6.14	Chaffinch	7.55
Dunnock	*6.76*	Whitethroat	5.77	Robin	7.55
Wren	5.72	Chaffinch	5.39	Wood Pigeon	4.56
Robin	5.20	Carrion Crow	5.15	*Tree Pipit*	*4.25*
Chaffinch	4.68	**Woodlark**	**4.59**	Whitethroat	4.25
Wood Pigeon	3.64	Long-tailed Tit	4.28	**Song Thrush**	**3.54**
Coal Tit	2.60	*Willow Warbler*	*4.28*	Chiffchaff	3.07
Goldcrest	*2.60*	**Skylark**	**4.22**	**Linnet**	**2.91**
Linnet	**2.60**	Robin	3.35	Blackcap	2.83
Skylark	**2.60**	Blue Tit	2.23	Coal Tit	2.83
Blackcap	2.08	Great Tit	2.23	*Goldcrest*	*2.83*
Willow Warbler	*2.08*	*Dunnock*	*2.05*	*Dunnock*	*2.36*
Blue Tit	1.56	*Green Woodpecker*	*1.67*	Long-tailed Tit	2.12
Great Tit	1.56	Pheasant	1.67	Carrion Crow	1.73
Kestrel	*1.56*	*Stonechat*	*1.67*	Blue Tit	1.42
Whitethroat	1.56	**Linnet**	**1.55**	Blackbird	1.42
Green Woodpecker	*1.39*	Chiffchaff	1.12	Great Tit	1.42
Carrion Crow	1.21	Magpie	1.12	**Turtle Dove**	**1.42**
Blackbird	1.04	R. L. Partridge	1.12	*Green Woodpecker*	*1.10*
Crossbill	1.04	*Cuckoo*	*0.99*	Jay	1.02
Greenfinch	1.04	Blackbird	0.81	Greenfinch	0.94
G. S. Woodpecker	1.04	Coal Tit	0.74	Garden Warbler	0.94
Bullfinch	**0.52**	Goldfinch	0.74	House Martin	0.94
Chiffchaff	0.52	**Turtle Dove**	**0.74**	**Woodlark**	**0.94**
Cuckoo	*0.52*	G. S. Woodpecker	0.62	*Cuckoo*	*0.47*
Goldfinch	0.52	Blackcap	0.56	Jackdaw	0.47
Jackdaw	0.52	*Goldcrest*	*0.56*	**Skylark**	**0.47**
Jay	0.52	*Kestrel*	*0.43*	*Curlew*	*0.24*
Long-tailed Tit	0.52	Crossbill	0.37	G. S. Woodpecker	0.24
Magpie	0.52	Garden Warbler	0.37	*Kestrel*	*0.24*
Stonechat	*0.52*	Jay	0.37	**Nightjar**	**0.24**
Cormorant	0.17	Hobby	0.19	Pheasant	0.24
Song Thrush	**0.17**	*Red Kite*	*0.19*	*Stonechat*	*0.24*
		Swallow	*0.19*	*Stock Dove*	*0.24*
		Song Thrush	**0.19**	Siskin	0.24
		Jackdaw	0.12	Goldfinch	0.16
		Stock Dove	*0.12*		
		Mistle Thrush	*0.06*		
		Sparrowhawk	0.06		

Appendix 1b Species Lists and relative abundance for each growth stage/ habitat class (all registrations). Species in bold are Red-listed in BoCC; species in italics are Amber-listed.

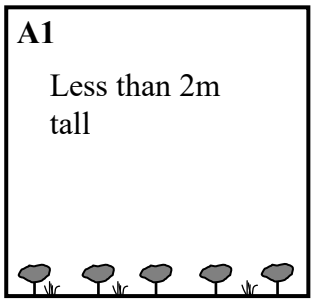
Thicket (Early & Late)		Pre-fell		Continuous Cover & Wet Woodland	
Species	**%**	**Species**	**%**	**Species**	**%**
Wren	12.00	Wren	15.38	Wren	11.99
Chaffinch	10.16	Wood Pigeon	12.80	Chaffinch	10.98
Wood Pigeon	9.47	Chaffinch	10.46	Wood Pigeon	9.86
Robin	8.72	Robin	9.84	Robin	7.70
Goldcrest	7.84	Coal Tit	9.10	Coal Tit	7.65
Coal Tit	7.36	*Goldcrest*	*5.34*	Great Tit	6.44
Willow Warbler	*4.64*	Chiffchaff	4.19	*Goldcrest*	*5.93*
Chiffchaff	4.32	Great Tit	4.19	Blue Tit	5.82
Blue Tit	3.52	Blue Tit	4.08	Long-tailed Tit	3.94
Song Thrush	**3.52**	Carrion Crow	3.31	Chiffchaff	3.70
Long-tailed Tit	3.20	Blackcap	3.24	Blackcap	3.66
Blackcap	3.12	Long-tailed Tit	2.83	Carrion Crow	3.07
Carrion Crow	2.93	**Song Thrush**	**2.13**	Blackbird	2.77
Yellowhammer	**2.37**	Jay	1.88	Jay	2.02
Great Tit	2.32	Blackbird	1.67	*Green Woodpecker*	*1.48*
Jay	2.29	*Dunnock*	*0.94*	G. S. Woodpecker	1.40
Blackbird	1.97	Treecreeper	0.84	**Song Thrush**	**1.16**
Garden Warbler	1.12	Greenfinch	0.63	Treecreeper	1.10
Dunnock	*1.07*	*Green Woodpecker*	*0.59*	**Marsh Tit**	**0.99**
Green Woodpecker	*0.99*	G. S. Woodpecker	0.52	*Dunnock*	*0.94*
Whitethroat	0.99	**Turtle Dove**	**0.52**	Whitethroat	0.62
Pheasant	0.88	Whitethroat	0.52	*Willow Warbler*	*0.62*
Magpie	0.72	*Willow Warbler*	*0.52*	Garden Warbler	0.59
Turtle Dove	**0.64**	**Bullfinch**	**0.42**	Pheasant	0.56
G. S. Woodpecker	0.56	*Firecrest*	*0.42*	*Mistle Thrush*	*0.51*
Tree Pipit	*0.53*	Garden Warbler	0.42	Nuthatch	0.40
R. L. Partridge	0.48	**Marsh Tit**	**0.42**	**Bullfinch**	**0.32**
Woodlark	**0.32**	**Yellowhammer**	**0.42**	Mallard	0.32
Treecreeper	0.24	Pheasant	0.31	*Stock Dove*	*0.32*
Cuckoo	*0.16*	*Stock Dove*	*0.31*	Magpie	0.30
Firecrest	*0.16*	**Skylark**	**0.31**	Greenfinch	0.25
Goldfinch	0.16	Goldfinch	0.21	Siskin	0.25
Moorhen	0.16	Magpie	0.21	*Firecrest*	*0.19*
Siskin	0.16	*Mistle Thrush*	*0.21*	*Mute Swan*	*0.19*
Skylark	**0.16**	Siskin	0.21	Jackdaw	0.17
Swift	0.13	*Cuckoo*	*0.10*	Crossbill	0.16
Bullfinch	**0.08**	**Linnet**	**0.10**	**Yellowhammer**	**0.16**
Curlew	0.08	Nuthatch	0.10	Goldfinch	0.13
Greenfinch	0.08	*Tree Pipit*	*0.10*	**S. Flycatcher**	**0.13**
Marsh Tit	**0.08**	Woodcock	0.10	*Tree Pipit*	*0.13*
Mistle Thrush	*0.08*	Collared Dove	0.03	*Cuckoo*	*0.11*
Nuthatch	0.08	Sparrowhawk	0.03	Hobby	0.11
Stock Dove	*0.05*			Moorhen	0.08
Jackdaw	0.03			Tawny Owl	0.08
Linnet	**0.03**			**Woodlark**	**0.08**
				Curlew	*0.05*
				R. L. Partridge	0.05
				Stonechat	*0.05*
				Starling	0.05
				Skylark	**0.05**
				Buzzard	0.03
				Goosander	0.03
				Grey Heron	0.03
				Kingfisher	*0.03*
				Kestrel	*0.03*
				Linnet	**0.03**
				Lesser Redpoll	*0.03*
				Meadow Pipit	*0.03*
				Redstart	*0.03*
				Turtle Dove	**0.03**
				Willow Tit	**0.03**

Appendix 1c Species Lists and relative abundance for each growth stage/ habitat class (all registrations). Species in bold are Red-listed in BoCC; species in italics are Amber-listed.

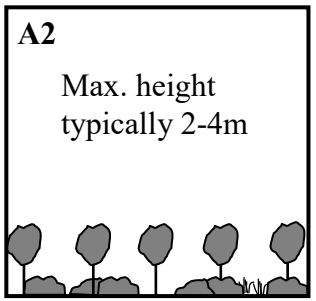
Heath Species	%
Skylark	**17.36**
Yellowhammer	**12.73**
Carrion Crow	7.48
Tree Pipit	*7.33*
Whitethroat	6.48
Linnet	**5.02**
Willow Warbler	*3.94*
Stonechat	*3.24*
Crossbill	3.01
Chaffinch	2.55
Wren	2.55
R. L. Partridge	2.31
L. B. B. Gull	2.16
Woodlark	**2.08**
Jackdaw	1.85
Chiffchaff	1.39
Long-tailed Tit	1.39
Swift	1.31
Garden Warbler	1.16
Green Woodpecker	*1.16*
Magpie	1.16
Robin	1.16
Wood Pigeon	1.16
Blue Tit	0.93
Cuckoo	*0.93*
Stock Dove	0.85
Coal Tit	0.69
Dunnock	*0.69*
Great Tit	0.69
Curlew	*0.54*
Jay	0.46
Kestrel	0.46
Mistle Thrush	0.46
Pheasant	0.46
Redstart	*0.46*
Swallow	*0.46*
Turtle Dove	**0.46**
Lapwing	0.31
Grey Wagtail	*0.23*
Sparrowhawk	0.23
Song Thrush	**0.23**
Black-headed Gull	0.08
Goldfinch	0.08
Hobby	0.08
Meadow Pipit	*0.08*
Grey Partridge	**0.08**
Rook	0.08

Appendix 2.

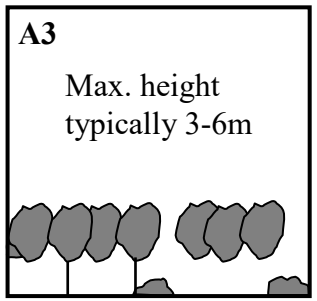
A) - WOODLAND GROWTH STAGE (A0 = Felled/Unplanted)



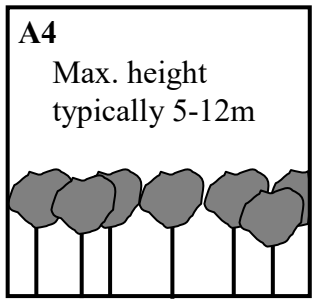
Recently planted/ open ground



Open thicket - dense vegetation

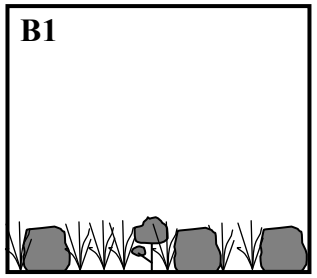


Closed canopy thicket - under growth shading or shaded out

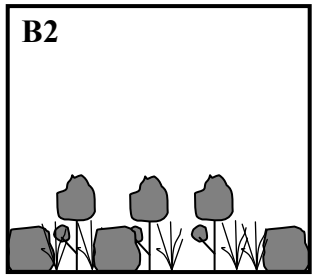


Late thicket - little or no undergrowth

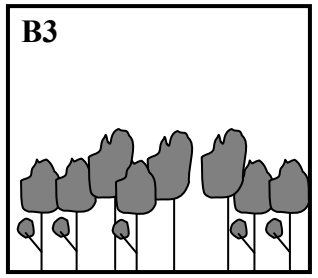
B) - DISTRIBUTION AND TYPE OF UNDERSTOREY WITHIN STAND -Combine codes, e.g. B1E, B2S



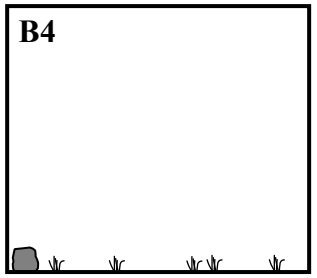
All or mostly dense low herbaceous and/or low woody vegetation



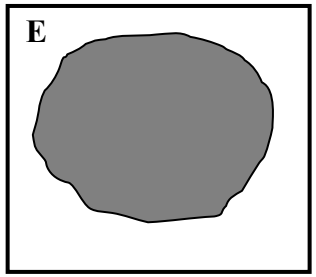
Mixture of low herbaceous bushes and woody vegetation plus taller shrubs



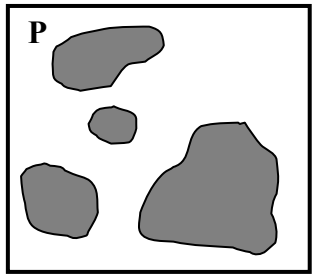
All or mostly shrubs, lacking in low herbaceous vegetation & bramble



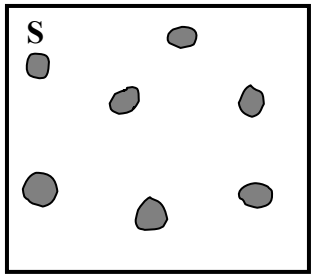
None, or very sparse



Extensive patches or complete coverage

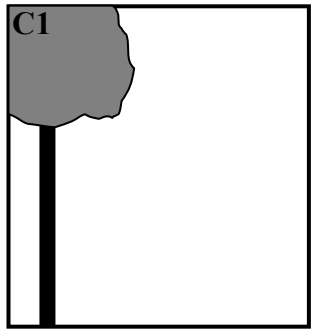
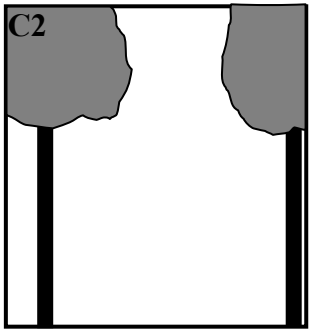
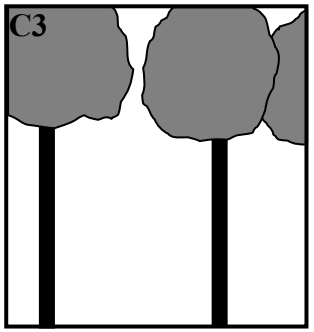
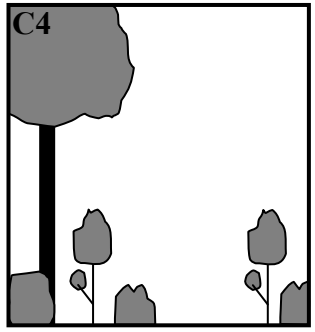
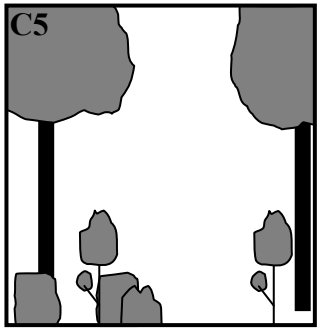
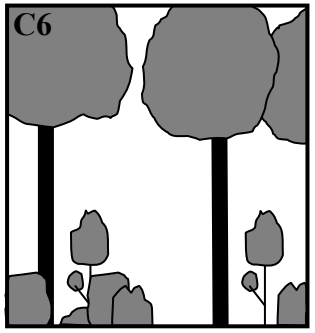
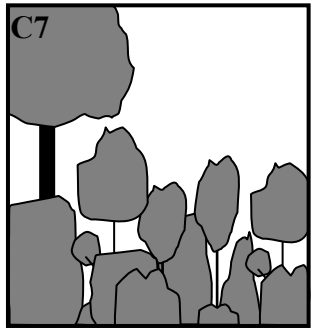
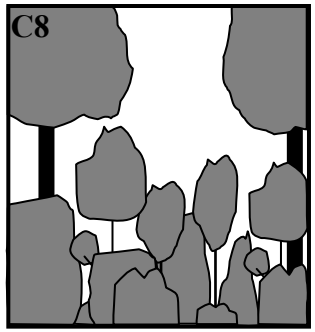
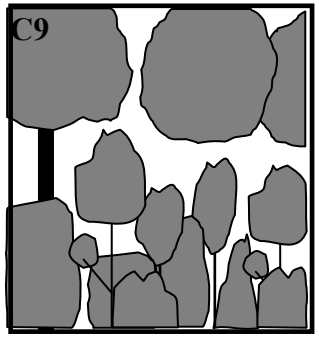


Patchy/clumped



Sparsely scattered

C) - MATURE WOODLAND STRUCTURE

	Mature woodland, with large canopy gaps, probably thinned	Mature woodland, open canopy	Mature woodland, closed canopy	**Stand structure classification for analysis**
Little or no understorey				**1**
Some/moderate understorey				**2**
Dense understorey				**3**

Images: Colin Brown / Sarah Kelman / Sarah Kelman. Cover image: Liz Cutting

Estimates of breeding bird abundance and habitat use in Thetford Forest Park.

This report presents the results from a breeding bird survey carried out in Thetford Forest Park in 2008. The main aims of this survey are to a) assess the importance of bird populations in Thetford Forest for the conservation of Birds of Conservation Concern (BoCC) (Gregory *et al.* 2002) and UK BAP Priority Species, b) determine breeding bird densities and species diversity within different habitat types and management regimes and c) to establish a baseline for future monitoring.

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