BTO Research Report No. 549

Final Report for 2009 on the Scottish Woodland Breeding Bird Surveys

Sarah Eglington & David Noble

A report of work carried out by the British Trust for Ornithology
under contract to the Forestry Commission Scotland
and Scottish Natural Heritage

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Executive Summary

- The volunteer-based BTO/JNCC/RSPB Breeding Bird Survey (BBS) has been the primary means of monitoring terrestrial breeding birds in the UK since 1994, and the data from this scheme is an integral element of national and regionally-based wild bird indicators. However, in Scotland, annual BBS coverage varies between 300 and 400 sites (about 10% of the total for the UK) which limits the number of species whose populations can be reliably monitored, and hence the number of species that can be included in composite bird indicators for Scotland.

- The BTO was commissioned by Forestry Commission Scotland and Scottish Natural Heritage to carry out a 3 year project from 2007/08 to 2009/10 to improve information on trends in woodland bird species and increase the range of species included in the woodland bird indicator for Scotland. This required the survey of additional wooded squares. Initially professional field surveyors were to be used for all the new squares, and then volunteers would be recruited to take over from them, with the aim of maintaining the higher level of sampling into the future.

- Initial scoping work showed that randomly selecting 1-km squares with a minimum of 15% woodland coverage would be the most efficient means of increasing the sample size for most of the target woodland species, i.e. those woodland species not then included in the woodland bird indicator for Scotland.

- The target starting sample in 2007 was 80 1-km squares, with an aspiration for 50% of those to be covered by volunteers by the third year of the project (2009). In 2007, professional fieldworkers surveyed 83 sites (ca 44% of them comprised to two adjoining 1-km squares, bringing the total to 120 squares) and these became the core sample for repeated annual coverage.

- Bird survey protocols were identical to those used in the BBS, requiring the recording of all birds seen and heard while walking along two pre-selected 1 km transects across each 1 km square, twice per season. Habitat information was also recorded along each transect using standard BBS protocols.

- More detailed habitat recording was trialled at a subset of sites. These included measures of the percentage cover of field, shrub and canopy layers, estimates of dead wood present, and identification of the dominant tree species in the wooded parts of the transect route.

- The number of sites surveyed by professional fieldworkers was reduced in each subsequent year (2008 and 2009) and due to low rates of volunteers recruitment, this resulted in reduced coverage overall in those years. In the third field season (2009), a total of 74 sites were surveyed (69 by professional fieldworkers and five by new volunteers), slightly short of the target of 80 annually. However, professional surveyors also surveyed an additional, adjacent, square at 32 sites (bringing the total number of squares surveyed to 106).

- In total, 111 species were recorded in the 2009 survey. Over the 106 squares (74 main and 32 adjacent) Chaffinch, Willow Warbler, Robin and Wren were the most widespread, being found on over 95% of sites. Of the target species, Treecreeper, Tree Pipit, Lesser Redpoll, Chiffchaff, Great Spotted Woodpecker and Blackcap were detected on at least 25% of sites, but occurrence rates for scarce woodland species were very low (Green Woodpecker on 1% sites and in 2009 Crested Tit was not recorded). In general, the most widespread species were also the most abundant on the square, i.e. with the highest counts. In comparison to similar sites (i.e. with at least 15% woodland) monitored by the core BBS, widespread bird species showed similar patterns but some of the scarcer woodland species (e.g. Green Woodpecker and Wood Warbler) were seen only on the Scottish Woodland BBS squares, not core BBS sites.

- Species occurrence rates on 68 main Scottish Woodland BBS squares that were surveyed in all three years of the survey (2007, 2008, 2009) showed little variation over time, with occurrence rates for only six species varying significantly between years; Siskin increased in their occurrence rates after 2007, Bullfinch and Spotted Flycatcher were detected much less frequent after 2007; and Goldcrest, Common Crossbill and Long-tailed Tit declined between 2008 and 2009.

- Patterns in counts were broadly similar to those for occurrence. It is difficult to interpret small changes in abundance over such a short period (2007 to 2009) but some patterns emerged. Numbers of small-bodied resident species such as Wren, Goldcrest, and Long-tailed Tit declined significantly in 2009. Blackcap, Bullfinch, Spotted Flycatcher, Sparrowhawk and Stonechat

showed evidence of significant declines in numbers over this period, whereas Woodpigeon and Willow Warbler showed evidence of increases.

- The habitat surveys revealed that the majority of surveyed woodland was coniferous, mainly classed as 'mid-age woodland.' Sitka Spruce was the dominant species, followed by Scots Pine and Sycamore. Dead wood was present on 75% of 'wooded or scrub' transect sections, and the majority of wooded sections had closed canopies (60% to 100% cover) and a sparse shrub layer.

- Trialling of more detailed habitat recording suggested that this is not a viable option for volunteer bird surveyors with little experience, or motivation for this element of the surveys, and its implementation required considerable effort from the survey organiser. Although these issues could be overcome by further training for professional fieldworkers, we do not feel that anything other than the standard habitat recording can be reliably collected by volunteers.

- Alternative means for collecting more specialised habitat data include using professionals on a periodic basis, perhaps every five years, and making greater use of remotely-sensed landscape and habitat datasets, such as aerial surveys or satellite images.

- Prior to 2010, the woodland bird species component of the annually-published Terrestrial Breeding Birds Indicator for Scotland included only two of the 10 target woodland bird species – Bullfinch and Blackcap – predicted prior to the start of this project to be to be reliably monitored through this additional coverage. These two species were added partly due to increases in the core BBS sample in Scotland between 2005 and 2007, and partly due to the increases in their numbers.

- Early in 2010, the 2007 and 2008 results of the Scottish Woodland BBS were included for the first time in the update of the Terrestrial Breeding Bird Indicator for Scotland for the period 1994 to 2008. Augmentation of the BBS data collected by volunteers with the results of the first two years of the Scottish Woodland BBS made it possible to calculate reliable integrated population trends for four additional target woodland species (Chiffchaff, Great Spotted Woodpecker, Treecreeper and Tree Pipit) and add these four species to the Scottish woodland bird indicator. The latest published value for the Terrestrial Breeding Birds Indicator for Scotland was published in 2010 and included data up to and including the 2008 breeding season. This showed that woodland birds continued to increase, by 7%, in Scotland between 2007 and 2008, and that the woodland bird index was 64% higher than its value in 1994.

- However, we failed to achieve the critical sampling threshold (a mean of 30 sites annually) for four target woodland species for which we predicted sufficient capacity to monitor at the start of the project - namely Spotted Flycatcher, Long-tailed Tit, Sparrowhawk and Common Crossbill. For two species on this list (Spotted Flycatcher and Common Crossbill), the failure might be partly attributable to marked falls in occurrence over this short period; but a continued increase in coverage will be necessary to be able to monitor any other, scarcer, woodland species.

- Rate of uptake of the Scottish Woodland BBS squares by volunteers was much less than hoped, despite effort to encourage recruitment through the BTO's regional network. We believe that this was due to competition for volunteers for the BTO's comprehensive new Bird Atlas 2007-11, and we expect BBS coverage, including coverage of Scottish Woodland BBS squares, to improve markedly post-Atlas, in 2012, when there will be a large pool of motivated and experienced bird surveyors to draw upon.

- Following the end of funding for the project in March 2010, the BTO has continued to promote volunteer take-up of these sites through its volunteer Regional Network (albeit still in competition with atlas surveying in 2010 and 2011). Other opportunities to recruit new volunteers by promoting the SWBBS results in various reports and birding media and through promotion by the BTO Scotland office.

1.   INTRODUCTION

Assessments of the population status of bird species are used for many conservation initiatives: for monitoring the status of native species in the area of jurisdiction, for identifying declines, for assessing population status for prioritising conservation efforts, and as indicators of the health of the landscapes in which they occur (for example, farmland, woodland, wetlands, coasts and marine areas). In the UK, the volunteer-based BTO/JNCC/RSPB Breeding Bird Survey (BBS) coordinated by the British Trust for Ornithology (BTO) has been the main survey of terrestrial breeding birds since 1994, annually providing population trends for more than 100 species at the national level. The BBS, often in combination with historical data from the Common Birds Census, is also an integral component of a broad suite of wild bird indicators produced annually for the UK and its constituent countries. The composite indicators are comprised of the population trends of groups of bird species associated with particular landscapes such as farmland, woodland and wetlands (e.g. Gregory *et al.* 2004).

In Scotland, BBS survey coverage is currently between 300 and 350 squares annually (about 10% of the total for the UK) and provides data to determine trends for 56 species. However, coverage of many less common species, or those with restricted ranges in Scotland, remains insufficient to be able to calculate population trends, or to be included in composite wild bird indicators. To address this issue, the BTO were contracted by the Forestry Commission Scotland, together with Scottish Natural Heritage, to develop a programme to augment survey coverage in Scotland – initially with professional field surveyors with a gradual phase of uptake of new survey squares by volunteers. The focus of this project was woodland birds and the sampling was designed to target these species. The aim of the contract was to improve capacity to report on trends in bird species of woodlands and adjacent habitats, to collect sufficient information to report on trends in a larger number of species, and to increase the species composition of the woodland bird indicator for Scotland, and thereby make it more representative.

Here, we report on the results of the third year of fieldwork (in 2009) to improve the coverage of key woodland bird species in Scotland, and assess the use of the habitat data collected by the bird surveyors. This updates information on the project already reported in Noble *et al.* (2008). We also summarise the first application of the results from the Scottish Woodland Breeding Bird Survey project, through the incorporation of these data in the species trends used in the latest version of the Scottish Terrestrial Bird Indicator for Scotland. The same protocols have been developed to combine these results with those from volunteer BBS sites in Scotland in calculating BBS trends for woodland species in Scotland for the next BBS report.

2.   METHODS

2.1   Scoping Work to Determine Sampling Design

Scoping work had previously been undertaken in 2006 to determine the most efficient sampling design to increase capacity to monitor a suite of scarce woodland bird species in Scotland. Target woodland species were defined as those for which BBS survey coverage needed to be improved in order to be able to generate a reliable population trend for Scotland, and which were therefore not in the Scottish Woodland Bird Index (Noble *et al* 2006). These species are as follows: Blackcap (*Sylvia atricapilla*), Tree Pipit (*Anthus trivialis*), Bullfinch (*Pyrrhula pyrrhula*), Common Crossbill (*Loxia curvirostra*), Great Spotted Woodpecker (*Dendrocopos major*), Treecreeper (*Certhia familiaris*), Chiffchaff (*Phylloscopus collybita*), Long-tailed Tit (*Aegithalos caudatus*), Jay (*Garrulus glandarius*), Sparrowhawk (*Accipiter nisus*), Spotted Flycatcher (*Muscicapa striata*), Wood Warbler (*Phylloscopus sibilatrix*), Garden Warbler (*Sylvia borin*), Green Woodpecker (*Picus viridis*), Redstart (*Phoenicurus phoenicurus*) and Crested Tit (*Lophophanes cristatus*). The agreed approach was to target 1 km squares in Scotland that were most likely to be occupied by these species. The basis of the stratification needed to be a standard measure, and hence the NIWT, the National Inventory of Woodland & Trees, was used to identify the target sites. In the first step, data from the BTO/JNCC/RSPB Breeding Bird Survey (BBS) were analysed to determine the proportion of key woodland species found on currently-surveyed squares with different degrees of woodland (15%, 25% and 35% as defined by NIWT. The results of the scoping work showed that although some coniferous woodland specialists (e.g. Crossbill, Tree Pipit) preferred the squares with a higher percentage of woodland, a 15% threshold was the most efficient stratification for increasing the sample size for most of the target species including Long-tailed Tit, Chiffchaff, Garden Warbler and Spotted Flycatcher.

2.2   Square Selection

Following presentation of the scoping analyses at a meeting of BTO, Forestry Commission Scotland, Forest Research, SNH and RSPB in February 2007, it was agreed to target site selection on land with a minimum of 15% total woodland, as defined by NIWT. Although 15% is a small proportion of the square, it was necessary to set a low minimum threshold in order to capture forest fragments as well as areas of continuous woodland. An initial sample size of 80 squares was chosen to be surveyed by professional fieldworkers, as likely to meet the requirements for providing sufficient data to estimate population trends for most (ideally 8-10) of the target species, within the available budget.

There are 23,745 1 km squares in Scotland which achieve the 15% threshold of woodland coverage. Based on NIWT, the total wooded area of these squares is 12,284 km^2 (hence about 50% of their total area). Prior to site selection, all BBS squares surveyed in any year between 1994 and 2005 in Scotland were removed from this list. Then, using ArcView GIS (ESRI 1996), an initial sample of 160 squares was selected randomly from the full list for allocation of the first 80 to the professional bird surveyors. More random sites were selected in this initial sample to allow for squares being excluded due to unsuitable habitat or lack of access, but sites were allocated in the order generated to maintain the integrity of the sampling design. Ordnance Survey maps of target 1 km survey squares were printed on A4 sheets and sites were checked for suitability (accessibility, whether the land was unrestricted for access, etc). Site references and maps of the final selection were provided to the fieldworkers at the start of each field season, along with BBS recording forms.
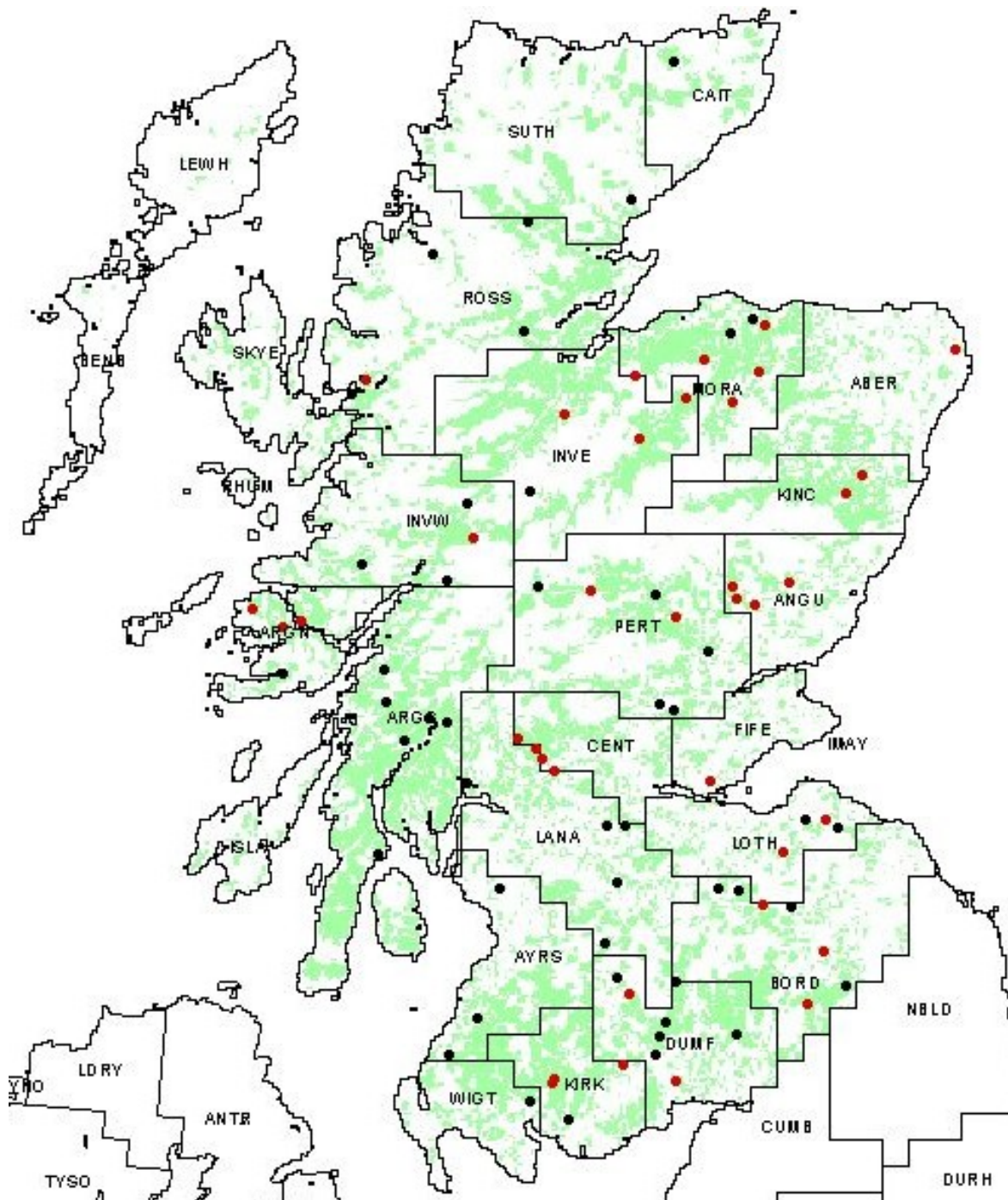
Figure 1   Map showing location (•) of all 83 main squares surveyed in 2007, and most subsequently in 2008 and 2009. The 37 sites where adjacent squares were also surveyed are shown in red. Areas of woodland are shown by light green shading.

2.3   Field Methods

Professional surveyors were interviewed and given standardised tests on their visual and aural bird identification skills and assessed during a practical field session. In total, seven surveyors (some part-time) were employed from April 1 to mid-July. All surveyors were briefed on the standard field protocols agreed by the partners, health and safety procedures and rationale for the project.

Field methods were identical to those used in the BBS scheme (see Risely *et al.* 2009). In summary, all surveyors made two visits, one from early April to mid May and a second between mid May to the end of June. On each visit, surveyors walk two pre-selected 1 km transects through each 1 km square and record all birds observed (seen and heard). Each transect is divided in five 200 m sections and birds are recorded at the section level. Therefore the total number of transects within any 1 km square is ten. The perpendicular distance of each bird from the transect is also allocated to one of three categories (less than 25 m, 25-100 m and greater than 100 m), and birds in flight were also recorded. This allows data to be resolved at the level of 200 m x 50 m, and 200 m x 200 m in subsequent analyses. In accordance with standard BBS protocols, all bird species are recorded during the surveys including any records of the target species (Blackcap, Bullfinch, Crossbill, Chiffchaff, Crested Tit, Garden Warbler, Great Spotted Woodpecker, Green Woodpecker, Jay, Lesser Redpoll, Long-tailed Tit, Redstart, Sparrowhawk, Spotted Flycatcher, Treecreeper, Tree Pipit and Wood Warbler).

Surveyors recorded the habitat type for each transect section using standard protocols, as well as any observations or signs of mammals. A hierarchical habitat coding scheme (Crick, 1992) was used to record both the primary habitat, and, if appropriate, the secondary habitat for each of the ten transect sections within each 1 km square. Because transect routes along rights of way such as paths or roads may separate two distinct habitat types, secondary habitat may be of equal importance to primary habitat. In this study, we are interested in two of the main (level one) habitats recorded by surveyors: woodland and scrubland / new plantations. Within these main categories, habitats were further categorised by woodland type (e.g. coniferous, deciduous, mixed waterlogged, young coppice, etc) as well as for the presence of other features (disturbance, age of stand, shrub layer, etc). The recording of these other features is not explored in this report but is likely to be the subject of subsequent analyses with a larger dataset.

At the end of the field season the professional surveyors entered the bird and habitat data into spreadsheets and returned this along with the paper copies of all of the forms. A copy of the maps of each of the surveyed squares with the route marked on it was also returned, to enable the same route to be followed in subsequent years. The electronic data from the fieldworkers' spreadsheets were then collated and standard checking procedures run to check for unusual records or missing data, such as unusually high counts or dates outside the usual survey period.

Because BBS habitat recording protocols are aimed at birdwatchers rather than professional foresters or botanists, they are relatively simple and focus on the structural complexity of the vegetation. Therefore, they may not provide the detailed information required to attempt to interpret causes of changes in woodland bird populations. In order to assess the practicality and effectiveness of more detailed habitat surveys, modifications of the BBS habitat recording methodology were undertaken at a subset of sites surveyed by a professional fieldworker. If these proved useful and feasible, the modified protocols could be used by volunteers and professionals in subsequent seasons. The proposed modifications were similar to those used widely by foresters and include measures of the percentage cover of the field, shrub and canopy layers, counts of deadwood standing or on the ground, and the dominant tree species in the forested sections of the transect routes. All were recorded at the 200 m transect section level.

2.4   Analysis

We calculated three measures of abundance for each species. Abundance is defined as the maximum count (of early and late visits) for each species recorded during the line transect surveys, on each 1 km square each year. This is the standard measure used in calculating BBS trends (Risely et al. 2009) and is more strictly relative abundance because it is a count, or sample, of the number of each species occupying the square. Moreover, comparisons of abundance across species should be undertaken with care because of interspecific differences in detectability. The second measure of abundance reported (counts from occupied squares only) provides an estimate of relative density on occupied squares and hence may not change if changes are mainly due to species disappearing from or moving to different sites. We also calculated rate of occurrence for each species, defined as whether a species was present

(detected) or absent (or not detected) within each square. Differences between abundance across years were tested using a generalized linear model with a Poisson distribution and a log link. Differences in the presence or absence of different species (occurrence) were tested using chi squared tests. All analyses were conducted using the statistical software package SAS.

In contrast to most bird indicators developed to date, trends for some of the species – those determined to be habitat generalists (Blackbird, Song Thrush, Blue Tit, Great Tit, Chaffinch, Dunnock, Cuckoo and Buzzard) – were habitat specific, i.e. derived solely from BBS 200m transect sections recorded as woodland. For woodland species determined to be woodland specialists (e.g. Coal Tit, Goldcrest, Wren, Willow Warbler, Siskin) the trend contributing to the indicator was based on all data on the grounds that the species would occur mainly or solely in the wooded areas anyway. Habitat associations were determined using Jacob's preference indices with BBS data from Scotland. Trend analyses took account of the non-independence of adjacent squares by incorporating a single site effect for each square or pair of squares, and including the number of squares at the site (one or two) as an offset in the model.

3. RESULTS

In the third field season (2009) of this project, six professional surveyors surveyed 101 squares (69 main squares and 32 adjacent squares) out of a total of 124 allocated. In addition, data was received for five main squares where volunteers had taken over sites previously covered by the professional surveyors, making a total of 74 main squares and 106 squares overall. This compares to 83 main squares and 37 adjacent squares in the first year (2007) and 71 main squares and 72 main squares and 34 adjacent squares in the second year (2008). Of the main squares, 68 were surveyed in all three years of the study, most of the shortfall in 2008 and 2009 being due to volunteers not taking over sites previously covered by the professional surveyors. There were complications in 2009 due to two fieldworkers resigning mid-way through the contract but we were able to reassign most of these squares to new fieldworkers, which enabled the squares to remain in the survey.

One hundred and eleven different species were recorded across all 106 squares, which is the same number recorded in 2008. A list of all species recorded in each year can be found in Appendix 2.

In the subsequent tables we focus on results from only the 'main' squares, the 74 surveyed in 2009 and the subset of 68 of those 74 that have been surveyed for all three years between 2007 and 2009. Additional results based on data from all 106 squares (main and adjacent) surveyed in 2009 and a subset of 96 of these that were surveyed in all years between 2007 and 2009 are provided in Appendix 3. The reason for treating these differently is that the most important figure is the number of surveyed sites (i.e. main squares) in the allocated sample. Data from adjacent squares (at the same site) provide additional data but cannot be treated independently in trend analyses and must be included as an offset in the model. This does nevertheless increase the effective sample size (although not as much as independent sites) because when population trends are calculated, it allows us to incorporate records of species detected in adjacent squares but not in the main square at the same site.

3.1 Bird Species Occurrence and Abundance in 2009

There were 74 main squares surveyed in 2009 (Table 1). Chaffinch, Willow Warbler, Robin and Wren were found in over 95% of squares. Thirteen more species occurred in more than 50% of the squares, although no target woodland species were included within this group. Tree Pipit, Lesser Redpoll, Chiffchaff, Great Spotted Woodpecker and Blackcap were target woodland species that occurred in at least 25% of the main squares, the same species as in 2008. Other target woodland species varied in their occurrence rate from Treecreeper (25%) to Green Woodpecker (1%) and in 2009 Crested Tit was not recorded. Patterns of abundance tended to concord with patterns of occurrence, although species often found in groups (Woodpigeon, Rook, Siskin and Coal Tit) tended to rank higher in abundance than in occurrence (Table 1).

The same patterns of occurrence were found in the overall sample of squares (main plus adjacent) in 2009 as for the main squares (Appendix 3).

Table 1.   Results from 2009: rates of occurrence and abundance of common and target woodland bird species in the main squares.

Species	Occurrence all Scottish woodland squares (n=74)	Abundance all Scottish woodland squares (n=74)	Abundance Scottish Woodland squares where species occurs
Chaffinch	1 (74)	17.91 +/- 1.21	17.91 +/- 1.21
Willow Warbler	0.99 (73)	12.61 +/- 1.16	12.78 +/- 1.16
Wren	0.97 (72)	9.36 +/- 0.56	9.63 +/- 0.54
Robin	0.96 (71)	7.47 +/- 0.56	7.79 +/- 0.56
Song Thrush	0.93 (69)	2.88 +/- 0.24	3.09 +/- 0.24
Siskin	0.88 (65)	4.95 +/- 0.5	5.63 +/- 0.51
Coal Tit	0.86 (64)	5.53 +/- 0.6	6.39 +/- 0.63
Wood Pigeon	0.82 (61)	14.45 +/- 2.89	17.52 +/- 3.38
Blackbird	0.7 (52)	2.8 +/- 0.4	3.98 +/- 0.49
Great Tit	0.65 (48)	2.03 +/- 0.28	3.13 +/- 0.34
Goldcrest	0.64 (47)	2.08 +/- 0.35	3.28 +/- 0.47
Carrion Crow	0.62 (46)	3.42 +/- 0.54	5.5 +/- 0.71
Meadow Pipit	0.61 (45)	4.69 +/- 0.97	7.71 +/- 1.43
Dunnock	0.58 (43)	1.57 +/- 0.21	2.7 +/- 0.25
Buzzard	0.53 (39)	0.88 +/- 0.12	1.67 +/- 0.13
Swallow	0.53 (39)	2.47 +/- 0.47	4.69 +/- 0.74
Blue Tit	0.51 (38)	2.15 +/- 0.36	4.18 +/- 0.5
Mistle Thrush	0.49 (36)	0.86 +/- 0.13	1.78 +/- 0.17
Pheasant	0.46 (34)	2.34 +/- 0.48	5.09 +/- 0.84
Lesser Redpoll	0.45 (33)	1.59 +/- 0.32	3.58 +/- 0.54
Great Spotted Woodpecker	0.41 (30)	0.64 +/- 0.11	1.57 +/- 0.16
Skylark	0.41 (30)	1.72 +/- 0.42	4.23 +/- 0.87
Cuckoo	0.38 (28)	0.53 +/- 0.09	1.39 +/- 0.12
Pied Wagtail	0.38 (28)	0.69 +/- 0.12	1.82 +/- 0.16
Chiffchaff	0.36 (27)	0.76 +/- 0.17	2.07 +/- 0.34
Oystercatcher	0.34 (25)	1 +/- 0.22	2.96 +/- 0.46
Tree Pipit	0.34 (25)	0.82 +/- 0.19	2.44 +/- 0.39
Blackcap	0.31 (23)	0.58 +/- 0.15	1.87 +/- 0.35
Jackdaw	0.3 (22)	3.03 +/- 1.23	10.18 +/- 3.78
Greenfinch	0.27 (20)	0.55 +/- 0.14	2.05 +/- 0.35
Rook	0.27 (20)	4.92 +/- 1.64	18.2 +/- 5.04
Goldfinch	0.26 (19)	0.66 +/- 0.18	2.58 +/- 0.46
Treecreeper	0.23 (17)	0.43 +/- 0.11	1.88 +/- 0.22
Jay	0.19 (14)	0.3 +/- 0.08	1.57 +/- 0.17
Bullfinch	0.18 (13)	0.27 +/- 0.08	1.54 +/- 0.18
Common Crossbill	0.16 (12)	0.47 +/- 0.21	2.92 +/- 1.07
Long-tailed Tit	0.09 (7)	0.22 +/- 0.1	2.29 +/- 0.64
Wood Warbler	0.07 (5)	0.11 +/- 0.06	1.6 +/- 0.6
Garden Warbler	0.05 (4)	0.08 +/- 0.04	1.5 +/- 0.29
Redstart	0.04 (3)	0.08 +/- 0.06	2 +/- 1
Sparrowhawk	0.04 (3)	0.04 +/- 0.02	1 +/- 0
Green Woodpecker	0.01 (1)	0.01 +/- 0.01	1 +/- 0
Spotted Flycatcher	0.01 (1)	0.01 +/- 0.01	1 +/- 0

Note on Table 1: The occurrence rate (and numbers of squares in which species were detected) and abundance of individual species in 2009 on the 74 main Scottish woodland survey squares only. Ranked in order of occurrence. Only species defined as target woodland species (those in **bold**), or that have a higher than 0.25 occurrence rate on the main Scottish woodland surveyed squares are presented.

3.2   Comparison of Woodland Bird Occurrence and Abundance between Years

Following the surveys in 2009, a total of 68 main squares had been surveyed in all three years of the study (2007 to 2009). A comparison of rates of species occurrence and abundance in that subset is provided in the following three tables (Tables 2, 3 and 4). Note that comparisons of species occurrence and abundance in the overall total of 96 1 km squares (68 main squares and 28 adjacent squares) that were surveyed in all three years of the study (2007 to 2009) are provided in Appendix 3. For reasons explained earlier, results from main and adjacent squares cannot be considered independently although the appropriate inclusion of data from adjacent squares in the modelling of population trends improves estimates and increases the effective sample sizes.

For each species and each measure of abundance (rate of occurrence, relative abundance, etc), we tested for significant inter-annual differences among the three years (2007, 2008 and 2009). Over such a short period of time (essentially an interval of two years), differences cannot be interpreted as trends, but examination of the abundance measures in the species showing significant effects provides an early indication of potential patterns. Differences in species abundance over time will later be formally tested by incorporating the data from the additional Scottish Woodland Breeding Bird Surveys into the annual modelling and reporting of BBS trends for Scotland.

Occurrence rates on the main Scottish woodland squares that were surveyed in all three years of the survey showed little variation between the three years except for six species whose occurrence rates varied significantly between years (Table 2). Siskin increased in their occurrence rates after the first year, Bullfinch and Spotted Flycatcher were detected much less frequently after the first year, whereas Goldcrest, Common Crossbill and Long-tailed Tit declined most markedly in 2009.

The patterns of occurrence based on the overall total number of squares (Table 11 in Appendix 3) revealed similar patterns to those in Table 2 (for Siskin, Goldcrest, Common Crossbill, Spotted Flycatcher and Long-tailed Tit) but also suggested differences among years in the occurrence rates of Sparrowhawk and Mistle Thrush, attributable to the increased power to detect differences based on a larger sample of squares when the information from adjacent squares was included. For several species, these differences are based on very low rates of detection, on less than 10 sites per year on average.

Tables 3 and 4 show the abundance of species in main squares that were surveyed in all three years. The only difference between these tables is that in Table 10, measures of abundance are based on all sites (and hence patterns are better matched to rates of occurrence) whereas in Table 11, measures of abundance are based only on sites where the species occurred (and hence better reflect difference in density on occupied sites). Differences in numbers of each species detected on the overall sample of squares (main and adjacent) provided in Table 12 and 13 in Appendix 3 reveal similar patterns but again, because of the larger sample of square included, more significant differences were detected. Across these sets of tables, it is difficult to draw conclusions from small, albeit sometimes significant, changes over such a short period of time and especially for species such as Common Crossbill and Siskin which are known to fluctuate markedly in numbers from year to year. Nevertheless, some clear patterns were apparent. Most noteworthy is the reduction in numbers of small-bodied resident species such as Wren, Goldcrest, and Long-tailed Tit in 2009 following a harsher than normal winter. If all squares, not just main squares, are included (see Table 12 in Appendix 3), Blue Tit can be added to this list. Other species showing inter-annual differences in abundance include Blackcap, Bullfinch, Spotted Flycatcher, Sparrowhawk and Stonechat (all showing some evidence of decline in numbers over this period) and Wood Pigeon and Willow Warbler (both showing some evidence of increase).

Table 2. Comparison of occurrence rates on main 1 km squares between years (2007 to 2009)

Species	Rates of occurrence 2007 (n=68)	Rates of occurrence 2008 (n=68)	Rates of occurrence 2009 (n=68)	Significant differences among years
Robin	1 (68)	0.99 (67)	0.96 (65)	
Wren	1 (68)	1 (68)	0.97 (66)	
Chaffinch	0.99 (67)	1 (68)	1 (68)	
Willow Warbler	0.99 (67)	0.94 (64)	0.99 (67)	
Song Thrush	0.94 (64)	0.93 (63)	0.93 (63)	
Coal Tit	0.85 (58)	0.87 (59)	0.88 (60)	
Goldcrest	0.82 (56)	0.87 (59)	0.63 (43)	**
Wood Pigeon	0.78 (53)	0.79 (54)	0.81 (55)	
Blackbird	0.75 (51)	0.76 (52)	0.71 (48)	
Blue Tit	0.71 (48)	0.57 (39)	0.53 (36)	
Great Tit	0.69 (47)	0.72 (49)	0.68 (46)	
Siskin	0.69 (47)	0.82 (56)	0.88 (60)	*
Meadow Pipit	0.65 (44)	0.57 (39)	0.63 (43)	
Carrion Crow	0.63 (43)	0.59 (40)	0.6 (41)	
Dunnock	0.59 (40)	0.65 (44)	0.54 (37)	
Buzzard	0.57 (39)	0.66 (45)	0.54 (37)	
Pheasant	0.53 (36)	0.53 (36)	0.46 (31)	
Skylark	0.49 (33)	0.46 (31)	0.4 (27)	
Swallow	0.49 (33)	0.5 (34)	0.51 (35)	
Mistle Thrush	0.47 (32)	0.34 (23)	0.5 (34)	
Lesser Redpoll	0.46 (31)	0.47 (32)	0.46 (31)	
Cuckoo	0.4 (27)	0.35 (24)	0.37 (25)	
Tree Pipit	0.38 (26)	0.32 (22)	0.34 (23)	
Bullfinch	0.37 (25)	0.13 (9)	0.18 (12)	**
Common Crossbill	0.37 (25)	0.57 (39)	0.18 (12)	***
Pied Wagtail	0.37 (25)	0.34 (23)	0.35 (24)	
Blackcap	0.35 (24)	0.38 (26)	0.29 (20)	
Curlew	0.34 (23)	0.35 (24)	0.25 (17)	
Oystercatcher	0.32 (22)	0.34 (23)	0.35 (24)	
Grey Wagtail	0.31 (21)	0.22 (15)	0.22 (15)	
Great Spotted Woodpecker	0.29 (20)	0.44 (30)	0.41 (28)	
Mallard	0.29 (20)	0.16 (11)	0.19 (13)	
Stonechat	0.29 (20)	0.22 (15)	0.18 (12)	
Treecreeper	0.28 (19)	0.31 (21)	0.24 (16)	
Goldfinch	0.26 (18)	0.24 (16)	0.24 (16)	
Greenfinch	0.26 (18)	0.26 (18)	0.28 (19)	
Jackdaw	0.26 (18)	0.32 (22)	0.28 (19)	
Chiffchaff	0.22 (15)	0.24 (16)	0.32 (22)	
Spotted Flycatcher	0.18 (12)	0.03 (2)	0.01 (1)	**
Long-tailed Tit	0.16 (11)	0.21 (14)	0.06 (4)	*
Sparrowhawk	0.13 (9)	0.1 (7)	0.04 (3)	
Wood Warbler	0.13 (9)	0.07 (5)	0.07 (5)	
Jay	0.12 (8)	0.15 (10)	0.18 (12)	
Green Woodpecker	0.06 (4)	0.01 (1)	0.01 (1)	
Redstart	0.06 (4)	0.04 (3)	0.04 (3)	
Garden Warbler	0.04 (3)	0.07 (5)	0.06 (4)	
Crested Tit	0.03 (2)	0.01 (1)	n/a	

Note on Table 2: The occurrence rate of individual species (and numbers of squares in which species were detected), in order of occurrence, on main Scottish woodland squares surveyed in all three years from 2007 to 2009. Only species defined as target woodland species (those in bold), or that have a higher than 0.25 occurrence rate on the Scottish woodland survey squares are presented. Significant inter-annual differences are coded as follows: * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.0001$

Table 3 Comparison of mean abundance on all main 1 km squares between years, 2007 to 2009.

	2007	2008	2009	Significant inter-annual effects
Robin	8.38 +/- 0.66	9.41 +/- 0.77	7.56 +/- 0.6	
Wren	13.15 +/- 1.1	14.57 +/- 1.41	9.15 +/- 0.58	**
Chaffinch	16.85 +/- 1.4	18.59 +/- 1.77	18.35 +/- 1.29	
Willow Warbler	11.1 +/- 1.18	11.72 +/- 1.21	12.54 +/- 1.23	
Song Thrush	2.93 +/- 0.24	3.1 +/- 0.33	2.74 +/- 0.23	
Coal Tit	5.99 +/- 0.67	6.91 +/- 0.78	5.51 +/- 0.61	
Goldcrest	5.6 +/- 0.65	6.47 +/- 0.92	2.19 +/- 0.38	
Wood Pigeon	5.54 +/- 0.7	10.79 +/- 1.79	13.56 +/- 2.84	
Blackbird	2.91 +/- 0.45	3.06 +/- 0.54	2.62 +/- 0.36	
Blue Tit	2.94 +/- 0.45	2.12 +/- 0.34	2.12 +/- 0.36	
Great Tit	2.6 +/- 0.37	3.13 +/- 0.44	2.04 +/- 0.28	
Siskin	6.25 +/- 1.1	8.34 +/- 1.04	4.93 +/- 0.51	
Meadow Pipit	5.03 +/- 0.78	5.16 +/- 0.94	4.74 +/- 1.03	
Carrion Crow	4.1 +/- 0.85	3.65 +/- 0.68	3.34 +/- 0.57	
Dunnock	1.34 +/- 0.2	1.85 +/- 0.28	1.38 +/- 0.21	
Buzzard	0.99 +/- 0.14	1.09 +/- 0.13	0.91 +/- 0.13	
Pheasant	1.85 +/- 0.32	2.51 +/- 0.46	2.32 +/- 0.5	
Skylark	1.84 +/- 0.36	2.38 +/- 0.67	1.66 +/- 0.45	
Swallow	1.54 +/- 0.28	1.82 +/- 0.4	2.21 +/- 0.42	
Mistle Thrush	0.96 +/- 0.15	0.53 +/- 0.1	0.9 +/- 0.14	
Lesser Redpoll	1.32 +/- 0.25	2.07 +/- 0.4	1.46 +/- 0.29	
Cuckoo	0.57 +/- 0.1	0.4 +/- 0.07	0.5 +/- 0.09	
Tree Pipit	0.91 +/- 0.25	0.65 +/- 0.16	0.79 +/- 0.19	
Bullfinch	0.74 +/- 0.14	0.28 +/- 0.1	0.28 +/- 0.08	***
Common Crossbill	1.74 +/- 0.45	4.28 +/- 1.41	0.51 +/- 0.23	
Pied Wagtail	0.56 +/- 0.1	0.54 +/- 0.11	0.62 +/- 0.12	
Blackcap	0.9 +/- 0.2	0.63 +/- 0.12	0.41 +/- 0.09	***
Curlew	0.88 +/- 0.31	1 +/- 0.28	0.78 +/- 0.23	
Oystercatcher	0.76 +/- 0.21	1.01 +/- 0.26	1.07 +/- 0.24	
Grey Wagtail	0.43 +/- 0.09	0.4 +/- 0.12	0.37 +/- 0.09	
Great Spotted Woodpecker	0.41 +/- 0.09	0.57 +/- 0.09	0.6 +/- 0.11	
Mallard	1.37 +/- 0.56	0.5 +/- 0.2	0.66 +/- 0.19	
Stonechat	0.6 +/- 0.13	0.43 +/- 0.11	0.26 +/- 0.08	*
Treecreeper	0.63 +/- 0.16	0.59 +/- 0.13	0.46 +/- 0.11	
Goldfinch	0.59 +/- 0.16	0.59 +/- 0.17	0.53 +/- 0.15	
Greenfinch	0.69 +/- 0.24	0.65 +/- 0.17	0.59 +/- 0.15	
Jackdaw	1.6 +/- 0.82	4.29 +/- 2.13	1.9 +/- 0.65	
Chiffchaff	0.46 +/- 0.16	0.5 +/- 0.15	0.65 +/- 0.17	
Spotted Flycatcher	0.21 +/- 0.06	0.03 +/- 0.02	0.01 +/- 0.01	***
Long-tailed Tit	0.5 +/- 0.19	0.47 +/- 0.13	0.16 +/- 0.1	*
Sparrowhawk	0.13 +/- 0.04	0.1 +/- 0.04	0.04 +/- 0.03	*
Wood Warbler	0.21 +/- 0.07	0.09 +/- 0.04	0.12 +/- 0.06	
Jay	0.19 +/- 0.07	0.18 +/- 0.06	0.26 +/- 0.08	
Green Woodpecker	0.12 +/- 0.06	0.01 +/- 0.01	0.01 +/- 0.01	***
Redstart	0.1 +/- 0.06	0.07 +/- 0.05	0.09 +/- 0.06	
Garden Warbler	0.13 +/- 0.09	0.12 +/- 0.06	0.09 +/- 0.05	
Crested Tit	0.09 +/- 0.07	0.03 +/- 0.03	n/a	*

Note for Table 3: The mean abundance ± s.e of species on main squares surveyed every year from 2007 to 2009. Only species defined as target woodland species in the proposal (those in bold), or that have a higher than 0.25 occurrence rate on the main Scottish woodland surveyed squares are presented. Significant inter-annual differences are coded as follows: * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.0001$

Table 4   Comparison of mean abundance on occupied 1 km main squares between years, 2007 to 2009.

	2007	2008	2009	Significant inter-annual effects
Robin	8.38 +/- 0.66	9.55 +/- 0.77	7.91 +/- 0.59	
Wren	13.15 +/- 1.1	14.57 +/- 1.41	9.42 +/- 0.56	***
Chaffinch	17.1 +/- 1.4	18.59 +/- 1.77	18.35 +/- 1.29	*
Willow Warbler	11.27 +/- 1.19	12.45 +/- 1.22	12.73 +/- 1.23	
Song Thrush	3.11 +/- 0.23	3.35 +/- 0.34	2.95 +/- 0.23	
Coal Tit	7.02 +/- 0.7	7.97 +/- 0.82	6.25 +/- 0.63	
Goldcrest	6.8 +/- 0.69	7.46 +/- 1	3.47 +/- 0.51	***
Wood Pigeon	7.11 +/- 0.77	13.59 +/- 2.09	16.76 +/- 3.37	***
Blackbird	3.88 +/- 0.53	4 +/- 0.65	3.71 +/- 0.42	
Blue Tit	4.17 +/- 0.55	3.69 +/- 0.44	4 +/- 0.5	
Great Tit	3.77 +/- 0.44	4.35 +/- 0.52	3.02 +/- 0.32	
Siskin	9.04 +/- 1.41	10.13 +/- 1.13	5.58 +/- 0.53	***
Meadow Pipit	7.77 +/- 0.98	9 +/- 1.34	7.49 +/- 1.48	
Carrion Crow	6.49 +/- 1.2	6.2 +/- 0.96	5.54 +/- 0.78	
Dunnock	2.28 +/- 0.25	2.86 +/- 0.35	2.54 +/- 0.27	
Buzzard	1.72 +/- 0.16	1.64 +/- 0.13	1.68 +/- 0.14	
Pheasant	3.5 +/- 0.46	4.75 +/- 0.67	5.1 +/- 0.87	**
Skylark	3.79 +/- 0.58	5.23 +/- 1.3	4.19 +/- 0.95	
Swallow	3.18 +/- 0.43	3.65 +/- 0.68	4.29 +/- 0.63	*
Mistle Thrush	2.03 +/- 0.18	1.57 +/- 0.14	1.79 +/- 0.18	
Lesser Redpoll	2.9 +/- 0.39	4.41 +/- 0.64	3.19 +/- 0.47	
Cuckoo	1.44 +/- 0.12	1.13 +/- 0.07	1.36 +/- 0.13	
Tree Pipit	2.38 +/- 0.55	2 +/- 0.34	2.35 +/- 0.41	
Bullfinch	2 +/- 0.22	2.11 +/- 0.35	1.58 +/- 0.19	
Common Crossbill	4.72 +/- 0.97	7.46 +/- 2.34	2.92 +/- 1.07	
Pied Wagtail	1.52 +/- 0.14	1.61 +/- 0.15	1.75 +/- 0.18	
Blackcap	2.54 +/- 0.4	1.65 +/- 0.2	1.4 +/- 0.18	**
Curlew	2.61 +/- 0.8	2.83 +/- 0.65	3.12 +/- 0.65	
Oystercatcher	2.36 +/- 0.5	3 +/- 0.58	3.04 +/- 0.47	
Grey Wagtail	1.38 +/- 0.16	1.8 +/- 0.34	1.67 +/- 0.16	
Great Spotted Woodpecker	1.4 +/- 0.15	1.3 +/- 0.1	1.46 +/- 0.16	
Mallard	4.65 +/- 1.73	3.09 +/- 0.94	3.46 +/- 0.46	
Stonechat	2.05 +/- 0.25	1.93 +/- 0.27	1.5 +/- 0.19	
Treecreeper	2.26 +/- 0.36	1.9 +/- 0.22	1.94 +/- 0.23	
Goldfinch	2.22 +/- 0.38	2.5 +/- 0.48	2.25 +/- 0.39	
Greenfinch	2.61 +/- 0.75	2.44 +/- 0.41	2.11 +/- 0.37	
Jackdaw	6.06 +/- 2.91	13.27 +/- 6.24	6.79 +/- 1.94	
Chiffchaff	2.07 +/- 0.55	2.13 +/- 0.42	2 +/- 0.39	
Spotted Flycatcher	1.17 +/- 0.11	1 +/- 0	1 +/- 0	
Long-tailed Tit	3.09 +/- 0.81	2.29 +/- 0.3	2.75 +/- 1.11	
Sparrowhawk	1 +/- 0	1 +/- 0	1 +/- 0	
Wood Warbler	1.56 +/- 0.29	1.2 +/- 0.2	1.6 +/- 0.6	
Jay	1.63 +/- 0.32	1.2 +/- 0.13	1.5 +/- 0.19	
Green Woodpecker	2 +/- 0.58	1 +/- 0	1 +/- 0	
Redstart	1.75 +/- 0.75	1.67 +/- 0.67	2 +/- 1	
Garden Warbler	3 +/- 1.15	1.6 +/- 0.4	1.5 +/- 0.29	
Crested Tit	3 +/- 1	2 +/- 0	n/a	

Note for Table 4: Mean abundance ± s.e of species on occupied main squares surveyed every year from 2007 to 2009 in squares where species was present (hence relative densities on occupied squares). Only species defined as target woodland species in the proposal (those in bold), or that have a higher than 0.25 occurrence rate on the main Scottish woodland surveyed squares are presented. Significant inter-annual differences are coded as follows: $* = P < 0.05$, $** = P < 0.01$, $*** = P < 0.0001$

3.3   Results from Core BBS Squares in 2009

Table 5 presents the results from a subset of 23 core BBS squares in Scotland which are more than 15% wooded as defined by NIWT (from a total of 328 squares surveyed in Scotland in 2009). Although comprised of only a small proportion of the total BBS sample in Scotland, this provides a comparison with measures of occurrence and abundance on the squares of the same type (i.e. with at least 15% woodland) but surveyed by volunteers rather than the professional surveyors. Note that in the estimation of population trends for all woodland species in Scotland, information from all core BBS sites would be included whether or not they contain 15% woodland. This greatly increases the effective sample for most species which occupy a variety of habitats including wooded areas of farmland and urban areas. As for the results from squares undertaken as part of the Scottish Woodland Breeding Bird Survey, the four most widespread species were Chaffinch, Robin and Willow Warbler and Wren. Most of the target woodland species were less widespread within the core BBS wooded squares and two species (Wood Warbler and Green Woodpecker) weren't observed at all. The most abundant species were Chaffinch, Willow Warbler and Wood Pigeon (Table 5).

Table 5. Measures of abundance on wooded sites from the core BBS sample in 2009.

	Occurrence on wooded BBS squares (n = 23)	Abundance in all wooded BBS squares (n=23)	Abundance in occupied wooded BBS squares
Chaffinch	0.96 (22)	16.61 +/- 2.22	17.36 +/- 10.62
Robin	0.96 (22)	6.74 +/- 1.35	7.05 +/- 6.48
Willow Warbler	0.91 (21)	9.61 +/- 1.7	10.52 +/- 8.17
Wren	0.91 (21)	7.39 +/- 1.72	8.1 +/- 8.25
Blackbird	0.87 (20)	5.7 +/- 1.47	6.55 +/- 7.05
Wood Pigeon	0.87 (20)	12.74 +/- 2.29	14.65 +/- 11.01
Song Thrush	0.78 (18)	3.61 +/- 0.74	4.61 +/- 3.54
Blue Tit	0.74 (17)	3.52 +/- 0.76	4.76 +/- 3.65
Coal Tit	0.74 (17)	6.43 +/- 2.91	8.71 +/- 13.94
Swallow	0.7 (16)	4.91 +/- 1.59	7.06 +/- 7.65
Buzzard	0.65 (15)	1.13 +/- 0.22	1.73 +/- 1.06
Carrion Crow	0.65 (15)	4.87 +/- 1.45	7.47 +/- 6.97
Siskin	0.65 (15)	3.74 +/- 1.06	5.73 +/- 5.07
Skylark	0.65 (15)	4.17 +/- 1.12	6.4 +/- 5.37
Great Tit	0.61 (14)	2.52 +/- 0.63	4.14 +/- 3
Pheasant	0.57 (13)	2.65 +/- 0.83	4.69 +/- 3.96
Dunnock	0.52 (12)	1.26 +/- 0.45	2.42 +/- 2.18
Curlew	0.48 (11)	1.17 +/- 0.35	2.45 +/- 1.7
Goldcrest	0.48 (11)	1.7 +/- 0.56	3.55 +/- 2.7
Jackdaw	0.48 (11)	3.04 +/- 1.02	6.36 +/- 4.88
Meadow Pipit	0.43 (10)	5.52 +/- 2.63	12.7 +/- 12.62
Mistle Thrush	0.39 (9)	0.96 +/- 0.46	2.44 +/- 2.18
Rook	0.39 (9)	4.17 +/- 1.68	10.67 +/- 8.07
Starling	0.39 (9)	4.43 +/- 2.92	11.33 +/- 14
Yellowhammer	0.39 (9)	1.48 +/- 0.53	3.78 +/- 2.56
Goldfinch	0.35 (8)	1.17 +/- 0.55	3.38 +/- 2.62
Blackcap	0.3 (7)	0.78 +/- 0.35	2.57 +/- 1.68
Great Spotted Woodpecker	0.3 (7)	0.87 +/- 0.33	2.86 +/- 1.6
Greenfinch	0.3 (7)	0.65 +/- 0.29	2.14 +/- 1.4
Linnet	0.3 (7)	0.83 +/- 0.35	2.71 +/- 1.7
Oystercatcher	0.3 (7)	1.35 +/- 0.91	4.43 +/- 4.37
Pied Wagtail	0.3 (7)	0.48 +/- 0.18	1.57 +/- 0.85
Whitethroat	0.3 (7)	0.78 +/- 0.44	2.57 +/- 2.13
House Sparrow	0.26 (6)	2.83 +/- 1.3	10.83 +/- 6.22
Lesser Black-backed Gull	0.26 (6)	1.78 +/- 1.11	6.83 +/- 5.32
Mallard	0.26 (6)	0.78 +/- 0.33	3 +/- 1.57
Stonechat	0.26 (6)	0.35 +/- 0.13	1.33 +/- 0.65
Wheatear	0.26 (6)	2.13 +/- 1.82	8.17 +/- 8.71
Chiffchaff	0.22 (5)	0.43 +/- 0.22	2 +/- 1.04
Lesser Redpoll	0.22 (5)	1.35 +/- 0.62	6.2 +/- 2.96
Bullfinch	0.17 (4)	0.22 +/- 0.11	1.25 +/- 0.52
Jay	0.13 (3)	0.22 +/- 0.14	1.67 +/- 0.67
Long-tailed Tit	0.13 (3)	0.22 +/- 0.13	1.67 +/- 0.6
Tree Pipit	0.13 (3)	0.48 +/- 0.27	3.67 +/- 1.31
Crossbill	0.13 (3)	0.22 +/- 0.15	2.5 +/- 0.74
Redstart	0.09 (2)	0.13 +/- 0.1	1.5 +/- 0.46
Spotted Flycatcher	0.09 (2)	0.09 +/- 0.06	1 +/- 0.29
Treecreeper	0.09 (2)	0.17 +/- 0.14	2 +/- 0.65
Garden Warbler	0.04 (1)	0.09 +/- 0.09	2 +/- 0.42
Sparrowhawk	0.04 (1)	0.04 +/- 0.04	1 +/- 0.21

Note for Table 5. The occurrence rate (and numbers of squares in which species were detected) and abundance of individual species on all 23 Scottish BBS survey squares that were at least 15% wooded in 2009. [Ranked in order of occurrence. Only species defined as target woodland species in the proposal (those in **bold**), or that have a higher than 0.25 occurrence rate are presented]

3.4 Incorporating Scottish Woodland BBS results into BBS trends

In the annual BBS report published in August 2010, results from the additional randomly selected 1-km squares surveyed as part of the Scottish Woodland BBS were incorporated into the annual Scottish BBS trends for the first time. As for standard BBS squares, only sites that have been surveyed in at least two years are included in the analyses. Population changes are estimated using a log-linear model with Poisson error terms. Counts are modelled as a function of year and site effects, weighted to account for differences in sampling effort, with standard errors adjusted for over-dispersion. The non-random habitat selection of the Scottish Woodland BBS squares was taken into account during this analysis. Joint trends for a suite of 22 species with substantial populations in Scottish woodland habitats were calculated using a combination of core BBS and additional Scottish Woodland BBS results (Table 6).

Table 6. Changes in measures of abundance of Scottish woodland bird species between 2008-09 and 1995 – 2008 as published in Risely *et al.* (2010).

Species	Sample	2008-09	1995-08	LCL	UCL
Buzzard	134	4	38*	10	76
Cuckoo	73	-16	6	-19	28
Great Spotted Woodpecker	41	-18	300*	177	500
Tree Pipit	32	-3	47*	3	111
Wren	221	-3	-8	-25	6
Dunnock	132	-10	54*	24	87
Robin	190	-9	25*	10	39
Blackbird	186	-2	32*	10	57
Song Thrush	169	-3	32*	11	57
Mistle Thrush	76	23	38	-5	100
Blackcap	48	-2	178*	75	321
Chiffchaff	40	-12	289*	134	596
Willow Warbler	203	5	16	-1	31
Goldcrest	92	-61*	16	-8	65
Coal Tit	123	-24*	-1	-21	24
Blue Tit	156	-4	3	-10	17
Great Tit	141	-12	53*	27	88
Treecreeper	35	-45*	-2	-39	53
Chaffinch	229	7	10	0	24
Siskin	71	-30*	20	-14	66
Lesser Redpoll	44	-9	-6	-51	49
Bullfinch	37	-10	23	-20	68

Note for Table 6: Values are percentage changes and are marked with * where the 95% confidence limits of the change do not overlap zero (indicating that there has been a significant change). The longer-term measure (labelled 1995-2008) is derived from the smoothed 1994 -2009 trend with the end years truncated. LCL = lower 95% confidence limit, UCL = upper 95% confidence limit.

Graphs of the annual trend indices from 1994 to 2009 are shown for some example species in Figure 2 below. Lesser Redpoll, Tree Pipit, Treecreeper, Great Spotted Woodpecker, Chiffchaff, Blackcap and Bullfinch are all target woodland species for which we were successful in increasing sample size. Wren, Song Thrush, Willow Warbler and Coal Tit are examples of common species, including some generalists. In this series of graphs the smoothed (mathematically equivalent to that produced

from a Generalized Additive Model (GAM)) and unsmoothed indices are presented. Dashed lines show the 95% confidence limits around the smoothed trend.

Figure 2.   Examples of BBS trends in Scotland (smoothed and unsmoothed) for a selection of woodland species. Dotted lines show the upper and lower 95% confidence limits of the unsmoothed trend.

(a)

(b)

(c)

Treecreeper

(d)

Great Spotted Woodpecker

(e)

Chiffchaff

(f)

Blackcap

(g)

Bullfinch

(h)

Wren
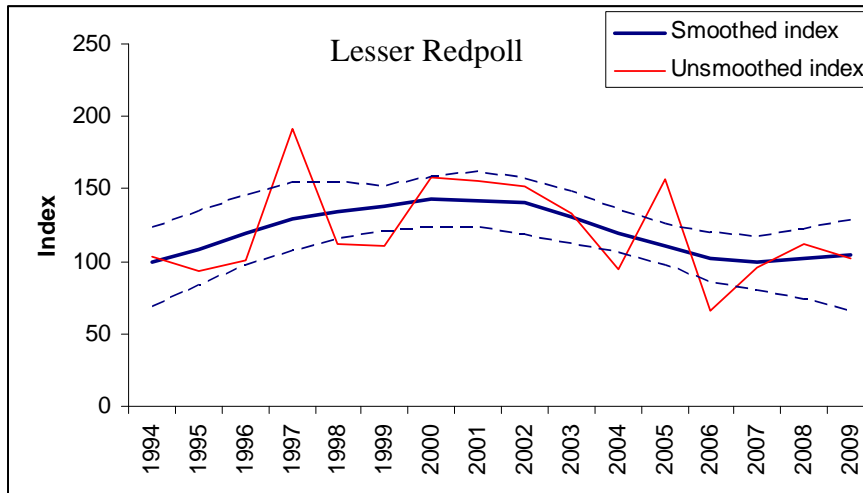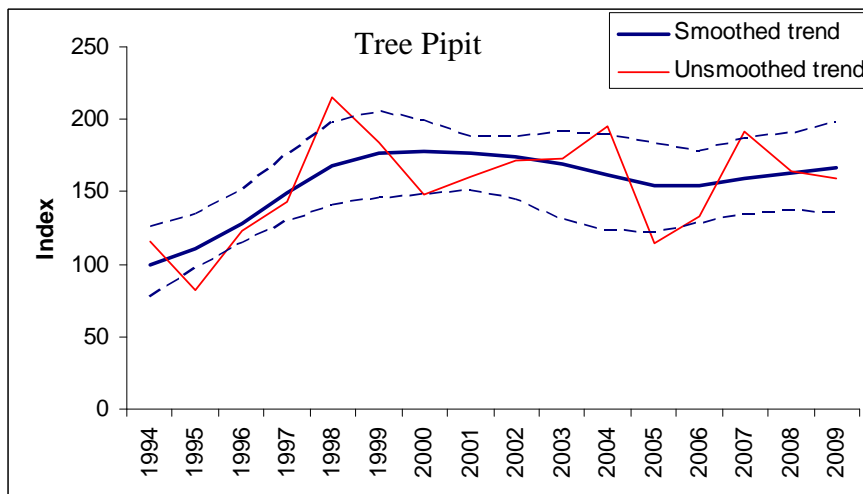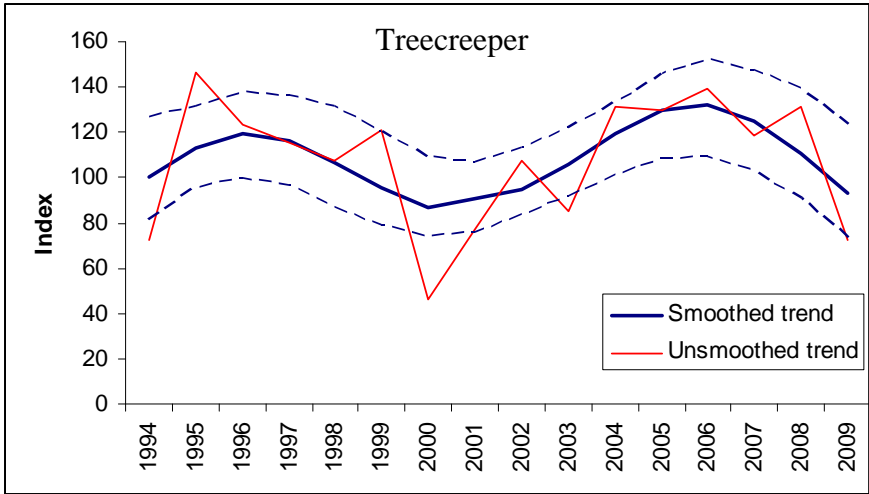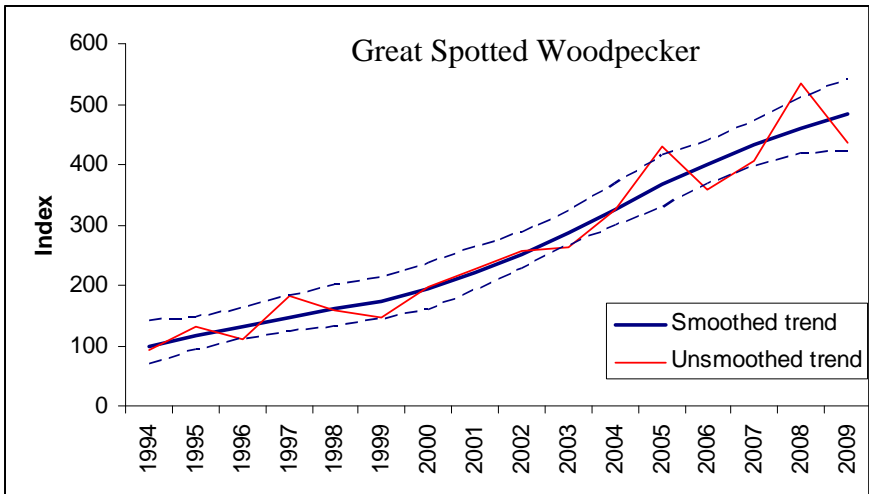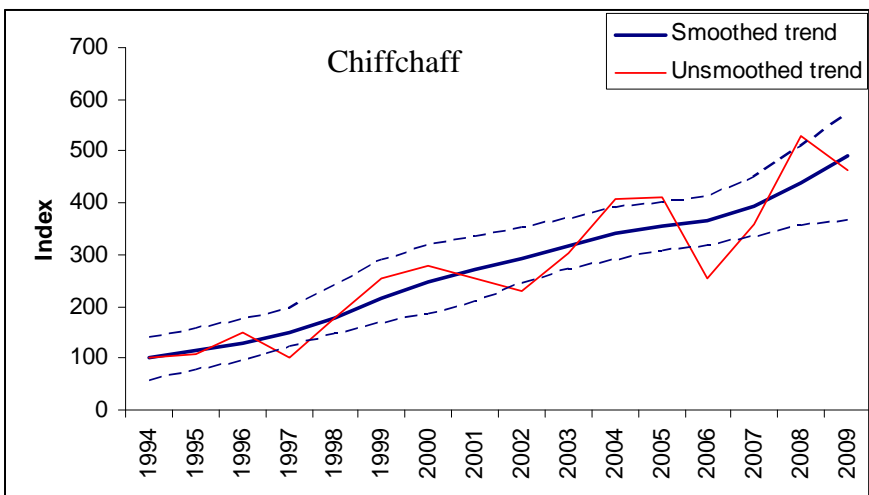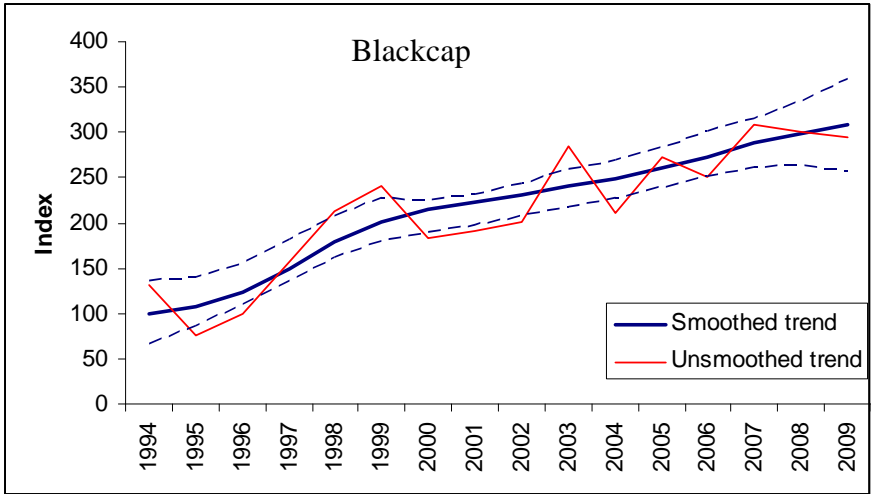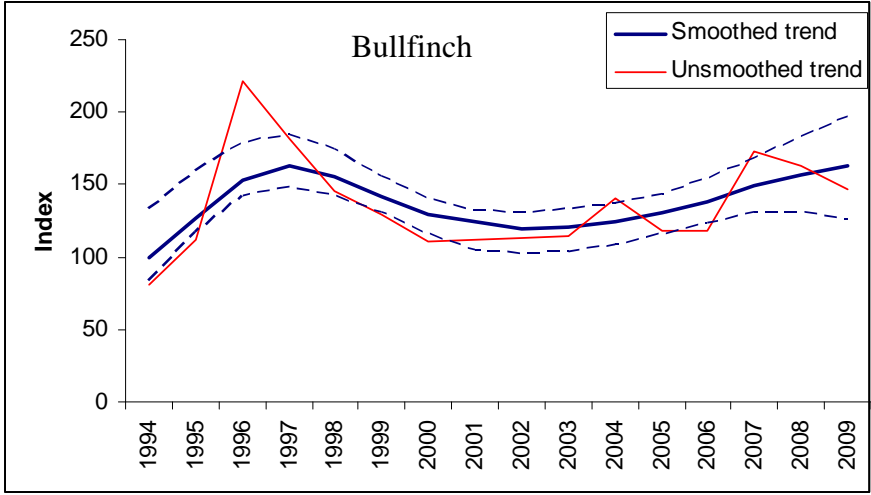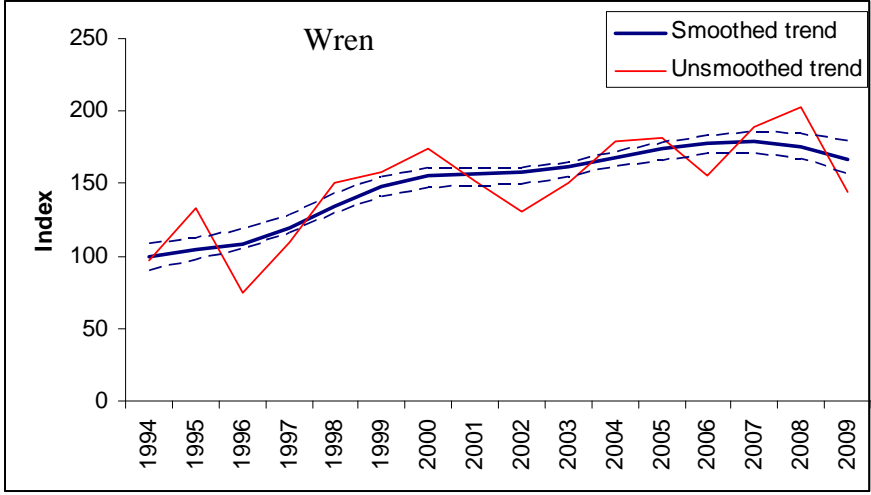
(i)
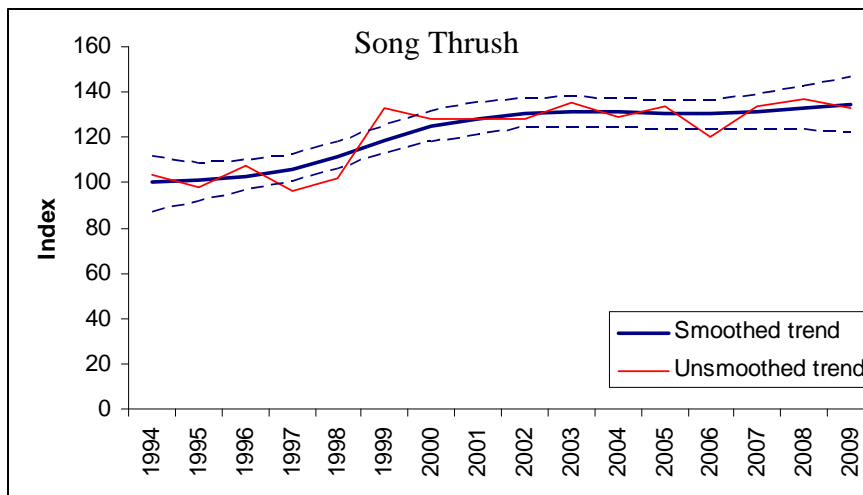
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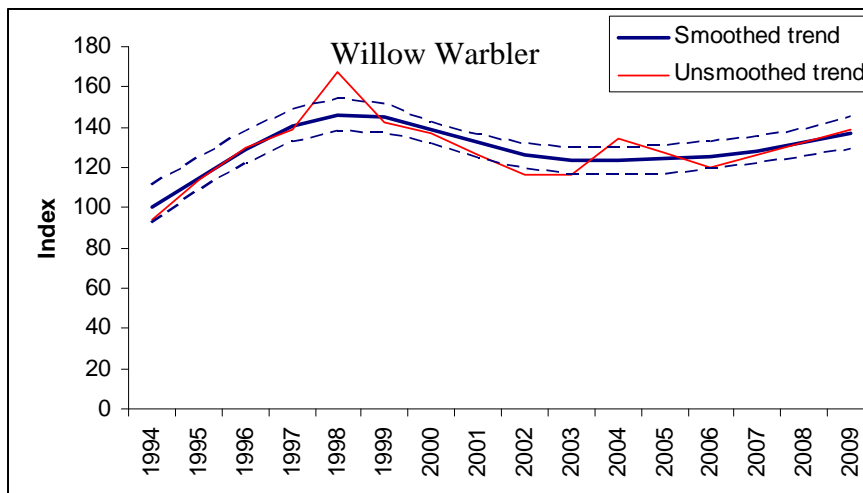
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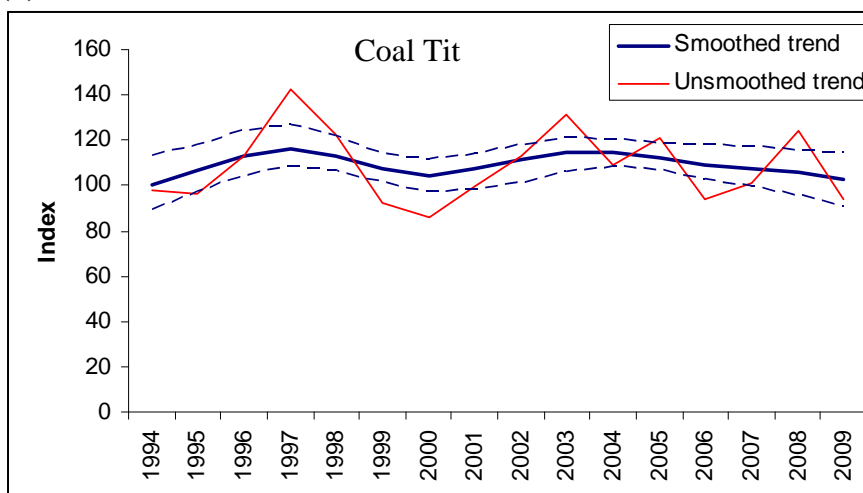
The Scottish Terrestrial Bird Indicator is provisionally scheduled to be updated in the winter 2010/2011, using the latest available trends for the period 1994 to 2009, for each of the constituent species. For the woodland specialist species in the indicator, and particularly for many of the target

woodland species, the trends used will be those presented above in Figure 2, based on data from all habitats. Hence, the same BBS trends that were reported in the 2009 BBS report (Risely *et al*. 2010) will be used for Great Spotted Woodpecker, Tree Pipit, Mistle Thrush, Robin, Blackcap, Chiffchaff, Willow Warbler, Goldcrest, Coal Tit, Treecreeper, Siskin, Lesser Redpoll and Bullfinch. However, in developing this indicator, the agreed approach was to use habitat-specific trends for the generalist woodland species, i.e. those that occupy more than one of the major habitats (e.g. farmland, woodland). Of the species in Table 6, woodland-specific BBS trends from 1994 to 2009 will be calculated for the generalists (Buzzard, Cuckoo, Wren, Dunnock, Blackbird, Song Thrush, Blue Tit, Great Tit and Chaffinch) and used in constructing the indicator..

3.5   Habitat Recording on Woodland Bird Breeding Survey sites in 2009

Five of the six professional fieldworkers were able to carry out standard BBS habitat recording in 2009, resulting in habitat data for 54 main squares. Analysis of the standard habitat data collected along the transect routes show that just over a third of the sites are comprised of at least 50% woodland as primary habitat in the main squares (Tables 7(a) and 6(b))

Table 7 (a)   Woodland or Scrub Primary Habitat – Number of main squares (n=54) surveyed where the primary habitat type is classed as woodland or scrub for 0-10 of the transect sections.

Number of transect sections	Woodland habitat	Scrub habitat
0	23	48
1	2	1
2	1	0
3	6	2
4	1	2
5	5	0
6	0	0
7	2	0
8	1	1
9	1	0
10	12	0

Table 7 (b)   Any Woodland or Scrub Habitat - Number of main squares (n=54) surveyed where the primary or secondary habitat type is classed as woodland or scrub for 0-10 of the transect sections.

Number of transects	Primary habitat	Secondary habitat
0	22	10
1	2	10
2	0	6
3	4	6
4	1	11
5	5	5
6	2	3
7	2	2
8	3	0
9	0	1
10	13	0

The majority of woodland (whether primary or secondary habitat) was coniferous (Table 8). The frequency distributions of deciduous and mixed woodland (the latter comprised of at least 10% of deciduous and coniferous) were similar. Very few sites were comprised of more than 50% deciduous woodland or 50% mixed woodland, whereas just over a third of the sites with coniferous woodland were more than 50% wooded.

Table 8. Number of squares with 0-10 transect sections classed as deciduous, coniferous or mixed woodland, based on primary and secondary habitat classifications.

Number of transect sections	Deciduous	Coniferous	Mixed (≥10%)
0	37	21	40
1	3	6	5
2	3	3	2
3	6	1	2
4	2	4	3
5	2	2	2
6	0	2	0
7	1	2	0
8	0	1	0
9	0	2	0
10	0	10	0

The age of the woodland was categorised using the following criteria: 'Mature woodland' - taller than 25 m and/or trunk diameter >50 cm, 'Mid age woodland' - 10-25 m tall, with a closed canopy, 'Young woodland' - 5-10 m tall, with an open canopy and woodland less than 5m tall (effectively scrub by some definitions). The majority of woodland surveyed in the habitat trial was classed as 'mid-age woodland' (99 transect sections) followed by 'young' (20 transect sections), 'shrub' (9 transect sections) and mature (8 transect sections).

The collection of additional habitat data to identify dominant tree species, amount and type of dead wood, and estimates of ground, shrub and canopy cover was evaluated using data for 160 transect sections. Of the transect sections surveyed, 136 contained woodland or scrub. On these, fourteen tree species or 'species groups' were recorded, with Sitka Spruce the most common dominant species, followed by Scots Pine and London Plane (Table 9).

Table 9. The number and percentage of transect sections (n=160) with each species (or species group) as the dominant tree species in the 16 squares in which additional habitat data were collected.

Species/Species group	Number transect sections	Percentage
Birch	9	6.62
Fir	2	1.47
Gorse	1	0.74
Hazel	2	1.47
Willow	1	0.74
Beech	3	2.21
Douglas Fir	2	1.47
Grey Willow	1	0.74
London Plane	11	8.08
Norway Spruce	2	1.47
Oak	4	2.94
Scots Pine	12	8.82
Sitka Spruce	82	60.29
Sycamore	4	2.94

Standing dead wood was present on 99 of 136 'wooded or scrub' transect sections. Large dead wood (>20 cm diameter) was present on just six transect sections but small dead wood (<20 cm diameter) was present on 93 transect sections. Lying dead wood was present on 105 of these transect sections. On three sites, this was defined as large lying dead wood, the rest were classified as small lying dead wood.

The percentage cover of the field layer, shrub layer and canopy layer was recorded in each transect section. The majority of wooded sections were recorded as having closed canopies (60% to 100%) and a sparse shrub layer, with most being 0 to 20%, up to a maximum of 50% in just one section. The field layer varied widely from 5% to 100%.

3.6   Developments in the Scottish Woodland Bird Indicator

The first version of a Terrestrial Breeding Birds Indicator for Scotland was generated using data from the first ten years of data from the BBS (1994 – 2004) and was published by SNH in 2007 (Noble *et al* 2006). The line for birds of woodland was a composite of the population trends of 17 species, all derived from the BBS except for Capercaillie for which data were available from periodically undertaken national surveys. It should be noted that the species composition of the Scottish woodland bird indicator line is based on habitat preference measures derived from Scottish BBS data, and where those were not available, based on the habitat categorisations in the 1988-91 Breeding Bird Atlas (Gibbons et al., 1993) and hence exclude some species found in upland wooded areas (e.g, Black Grouse).

The latest update of this indicator was carried out in January 2010 (Figure 3, and see Anon 2010). As well as using the results from Scottish BBS sites between 1994 and 2008, the constituent species trends also incorporated data collected as part of the Scottish Woodland Bird Surveys where those data fall within the same time period (hence 2007 and 2008). This was the first time that the data from the Scottish Woodland Bird Surveys could be used in the indicator because: (i) sites must be surveyed in at least two different years before trend measures can be calculated, and (ii) the scheduled updates of population trends using the BBS data collected by volunteers. The submission of data collected by volunteers in the BBS, and the subsequent data checking and analyses, is one of the rate-limiting steps in the updating of population trends, and hence updates for each field season are typically reported the following spring. For the January 2010 update of the Terrestrial Breeding Birds Indicator for Scotland, this meant that volunteer data from 1994 to 2008 were available, but not for 2009, and therefore we could use the Scottish Woodland Breeding Bird Survey data collected in 2007 and 2008, but not yet the 2009 results. Changes in abundance for each species in the January 2010 update of the Terrestrial Breeding Birds Indicator for Scotland can be seen in Appendix 1.

Figure 3.   Terrestrial Breeding Birds Indicator for Scotland: 1994-2008 (as updated in January 2010).
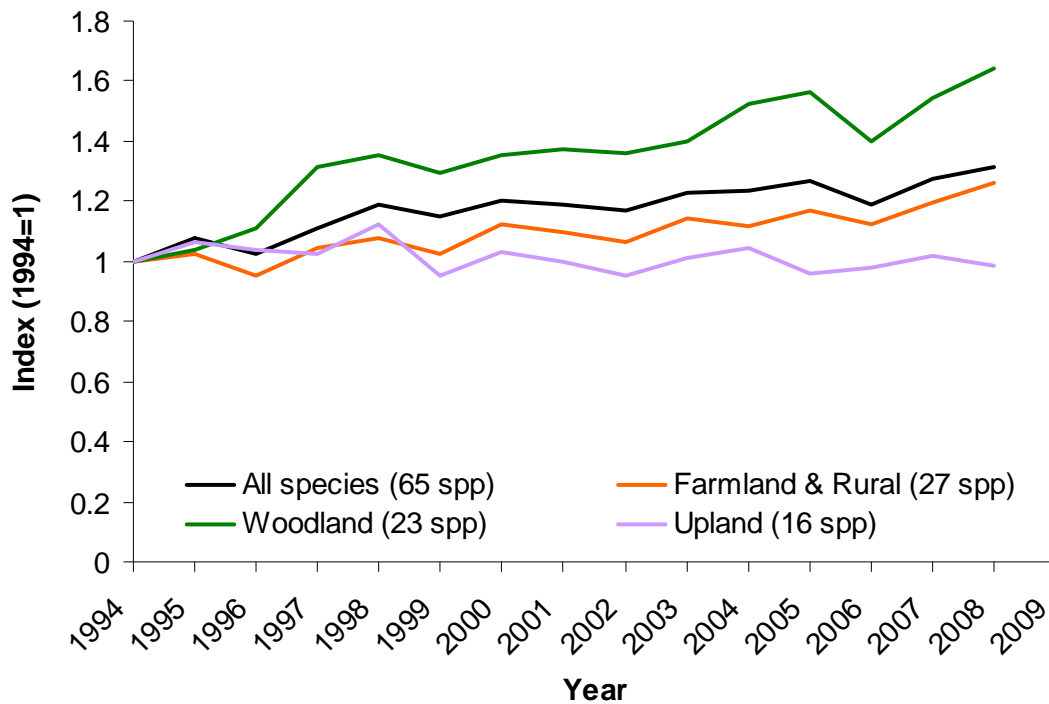
Prior to this latest update of the terrestrial birds indicator for Scotland, small increases in BBS coverage in Scotland combined with increasing trends in a few species, meant that it was possible to index two additional woodland species - Bullfinch, a woodland specialist, and Blackcap, an increasing generalist. In recent years, the number of 1 km BBS squares where these species are regularly recorded managed to reach the threshold of 30 sites for indexing, and hence inclusion in the indicator. However, despite small increases in BBS coverage, it was still not possible to generate Scottish population trends for any of the other key woodland species currently missing from the indicator, namely Chiffchaff, Garden Warbler, Long-tailed Tit, Spotted Flycatcher, Great Spotted Woodpecker, Treecreeper, Tree Pipit, or Crossbill. Incorporating the 2007 and 2008 results of the Scottish Woodland Bird Surveys, alongside the core volunteer BBS data from 1994 to 2008 has made it possible to calculate new integrated population trends for another four species (Chiffchaff, Great Spotted Woodpecker, Treecreeper and Tree Pipit) now included in the indicator for the first time. The additional data also improved the trend estimates for two species; Bullfinch and Blackcap. Nevertheless, it seems unlikely that the scarce and declining populations of Spotted Flycatcher and Garden Warbler will be monitored on a sufficiently large sample to calculate reliable trends for use in indicators. Changes in the British range of other species, however, as a result of climate change and/or changes in land use, may result in the later inclusion of additional species in the Terrestrial Breeding Birds Indicator for Scotland.

It is important to note that the Scottish Woodland Bird Survey results have also greatly improved the quality of data for the remainder of the species already included in the woodland indicator, both in terms of representativeness and in the likelihood of statistically significant change. In the latest update of the Terrestrial Breeding Birds Indicator for Scotland, we use a bootstrapping approach to calculate the statistical significance of changes in the woodland bird element of the indicator, from the start data in 1994, and for each inter-year interval. Shown below (Figs 4 and 5), these calculations reveal that woodland birds continued to increase between 2007 and 2008 (by almost 7%) and this was significant at the 95% level (confidence interval: 1.001 to 1.139). This is the 2nd consecutive year of significant increase since a significant decline between 2005 and 2006, following a period of steady growth but with relatively little significant year to year change since 1997. The current woodland bird index is

64% higher than in the start year of 1994, with 95% confidence limits for the overall increase ranging from 51% to 82%.

Figure 4.   The trend-line, with boot-strapped confidence intervals, for woodland birds in the Terrestrial Breeding Birds Indicator for Scotland: 1994-2008 (23 species).
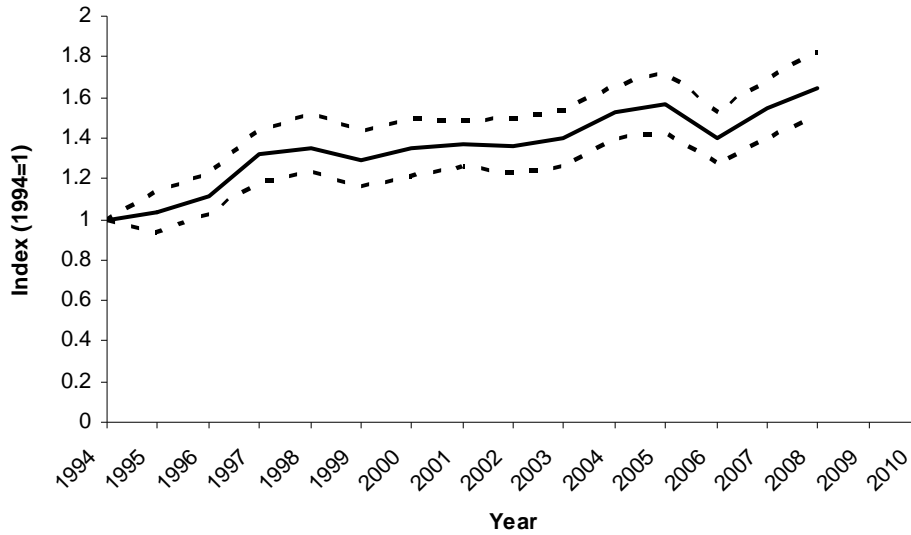

Figure 5.   Year to year changes, with 95% confidence estimates, in the trend for woodland birds in the Terrestrial Breeding Birds Indicator for Scotland: 1994-2008 (23 species).
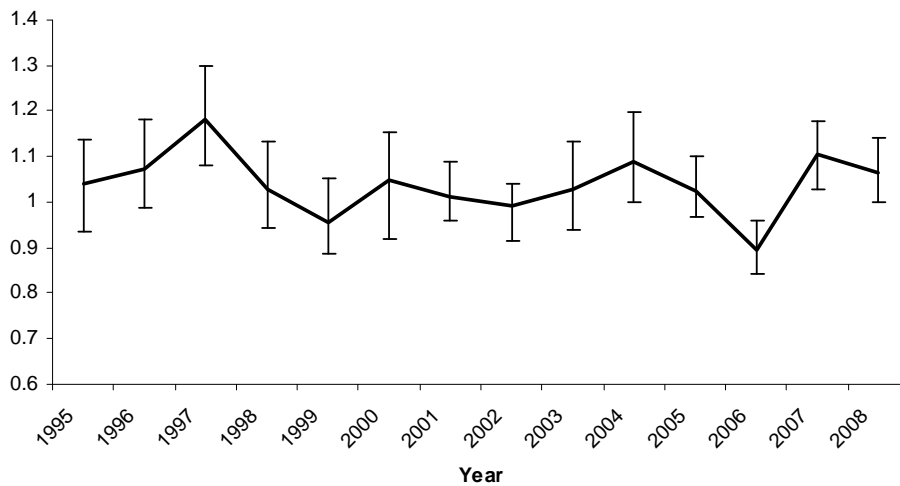
4.   DISCUSSION

4.1   Feasibility of Using Surveyor-Collected Data on Woodland Habitat

Surveyors undertaking Scottish Woodland Bird surveys were asked to record habitat data along their transect route following standard BBS protocols, i.e. using the same procedures as those used by volunteer participants in the BBS. The habitat details recorded are part of standardised hierarchical scheme devise used across most BTO surveys (see Crick, 1992) but are designed for non-habitat specialists (the bird surveyors) to record broad habitat types (e.g. coniferous woodland, moorland, reed swamp) rather than detailed habitat descriptions. Moreover, given the general unpopularity of habitat recording among bird surveyors, BBS habitat recording is designed to be easy to undertake while walking the route and does not require specialist knowledge such as the identification of plant species.

As part of the professional woodland bird surveys undertaken in the Scottish Woodland Bird Survey project 2007-2009, we trialled modifications of the BBS habitat recording at a subset of sites, to assess whether it would be feasible to roll out these protocols to volunteers and professionals in subsequent seasons. These measures related mainly to the presence of dead wood, percentage cover of the field layer, shrub layer and canopy layer, stand age, and identification of the dominant tree species in the forested sections of the transect route. These data were generally recorded at the 200 m transect section level, but for some trials, we assessed habitats only in the first 50m of the wooded transect sections. The aim of this work was to assess whether bird surveyors undertaking bird surveys could also collect information on the surrounding forest. The results of earlier trials of habitat recording are covered by Noble *et al*. (2008). In the main, useful data were successfully collected but the following issues with the methodology were highlighted by fieldworkers;

4.1.1   Difficulties in assigning woodlands to an age category

Fieldworkers reported that they had difficulties with assigning woodlands to an age category based on the definitions provided in the methodology. Whereas, 'young plantations' are defined as being 5 – 10 m, usually with open canopy, fieldworkers encountered 'young plantations' that were less than 5 m height. Another problem is that in highly exposed areas, trees which may be several decades old can be less than 10 m. Thus, a definition based strictly on height of trees may not be appropriate.

4.1.2   Concern over the level of accuracy of estimates of percentage cover

There was general concern over the difficulty of accurately estimating the percentage cover of the different vegetation layers and fieldworkers reported that it was extremely hard to estimate the cover over an area as large as a transect section. One fieldworker highlighted the fact that some woodlands can have very dense ground layers composed almost entirely of mosses, which are not herbaceous plants, and hence are not recorded in the field layer.

4.1.3   Problems with identifying tree species

Fieldworkers were essentially ornithologists, not specialists in tree identification, and therefore found it difficult to identify key tree species. It is possible that in some cases, incorrect tree species were recorded, judging from some of the more surprising results from the habitat data in the first year. There were also methodological issues in identifying the dominant species in a particular stand

4.1.4   Assessing amount and type of dead wood

Recording dead wood also resulted in difficulties, some related to the definition of small and large deadwood, as well as standing and lying, but mainly due to the fact that it could not be easily ascertained from the actual transect route and hence required surveyors to undertake parallel walks

within the wooded sections of their route (eventually we decided upon the first 100 meters of wooded habitat). This took extra time and could not be undertaken at the same time as bird recording.

4.1.5 Bias in estimates of habitat resulting from transect routes

The fact that many transects follow roads and forest tracks may have an impact on the tree species recorded. One field worker reported finding more deciduous trees than expected due to the increased light in these areas, whereas in the forest 'proper' it would be too dark for such species to grow. Recording along routes may also influence the amount of deadwood that fieldworkers encounter as due to health and safety reasons, piles of deadwood are routinely moved from the side of forest tracks during FCS management. It is difficult to assess how important this issue is, given that the bird are also recorded along these routes. However, if the aim is to identify possibly quite subtle effects of such factors on bird abundance, it is critical to ensure that bird and habitat features are compared at the same spatial scale, and the effort required for volunteer bird surveyors to collect this information may be counter-productive.

4.1.6 Conclusions from trials to collect additional habitat data

There are numerous methods for undertaking forest surveys in a proficient way. However, the aim of this work was to assess whether bird surveyors undertaking bird surveys could also collect useful habitat information. Overall, trialling of detailed habitat recording by bird surveyors suggested that this is not a very viable option. The trials involved considerable liaison and discussion with fieldworkers during the field season (with resource implications for the organiser), as well as further changes or caveats being added to the results following habitat data checking at the end of the field season. We considered ways to address the issues highlighted above, including to provide volunteers with further training such as a one day training course hosted by Forest Research, for volunteers to attend. Such workshops could address forestry and vegetation survey techniques such as how to identify tree species, the presence of dead wood, and how to estimate percentage cover of vegetation layers more accurately. It may also be possible to set up some kind of telephone help network, whereby volunteers are given the telephone number of a designated FCS employee, who would be available to answer any specific questions that arise in the field.

Most of these obstacles could be overcome with training and experience in the case of professional fieldworkers, but we do not feel that recording detailed habitat features is possible, and certainly not reliable, using volunteers – bearing in mind that using volunteers to collect data from these sites is one of the ultimate aims of the project and the only way that the surveys are likely to be sustained over the long term. Although standard habitat recording is not very popular amongst BBS volunteers, there may be ways that it could be modified to make the required information simpler and easier to collect. These include adapting the instructions and providing a clearer methodology to fieldworkers, clarification of stand age / height categories and by providing fieldworkers with a simple photo ID guide for tree species. However, this is unlikely to resolve all of the issues, and has resource implications for running the survey.

Overall we think that the approach outlined above would have limited success, and the potential for significant resource implications. A heavy focus on habitat recording may even be counter-productive to the aim of increasing uptake of these squares by volunteers primarily motivated by their interest in birds. Instead, we think two other approaches are preferable.

One is to consider the use of professionals (possibly forest surveyors or botanists but with sufficient training, this could be bird surveyors) in collecting information on these features on a periodic basis, perhaps every five years. BBS squares are at fixed locations and surveyed every year so investing in periodic habitat recording could provide valuable data with longer-term relevance. Periodic rather than annual habitat surveys may work particularly well in woodlands where attributes such as tree species, age structure and dead wood content, are not likely to change quickly .

The second approach would be to make much greater use of external landscape and habitat datasets, including a range of remotely-sensed attributes, which would also only be required periodically (also probably only updated periodically). Where such data are more difficult or expensive to obtain, they would only be required for the relatively small number of 1 km BBS squares, or wooded squares, in the survey.

An important point is that efforts to collect more detailed habitat information need to take into account the questions that are likely to be asked of these data, i.e. the strength of evidence that these factors affect the distribution and abundance of the bird species monitored through this survey. Fuller (1995) and others have shown that the abundance of bird species is linked to such factors as woodland stand structure, tree species and cover, but further work is required to establish the key factors and the strength of these relationships in Scottish woodlands before investing too heavily in largely exploratory work. Bird abundance may be most strongly influenced by stand structure and complexity (rather than tree species), by factors not included in the habitat recording (for example presence of bracken, soil moisture), as well as by conditions outside the breeding areas, particularly for migrant species. In relation to the habitat measures collected to date, some of the key questions to be addressed include: Does the presence and amount of deadwood influence the presence/absence or abundance of particular bird species, and if so, at what scale and through what mechanisms? What is the role of stand age (and succession) on bird occurrence and abundance? Is bird species presence influenced by a particular tree species, or by the woodland tree species composition? Dead wood, for example, is likely to be important to woodpeckers (Smith 2007) and old-growth forest is likely to be important for some Scottish woodland specialists such as Capercaillie, Crested Tit, Redstart and the crossbill species (Summers 2007) but unlikely to benefit other species dependent on young growth and under-storey vegetation. To answer these questions, we advocate: (i) further exploration of existing data sets to identify relationships between such attributes of woodland, and (ii) further evaluation, through reviews or further analyses, of the importance of habitat attributes that could be collated using any of the proposed approaches (by volunteers, periodic habitat surveys by professionals, or remotely-sensed data). Although it is clearly important to be able to link observed changes in woodland bird populations with changes observed in potential key drivers (including stand structure, dead wood, etc) for evidence that these are likely causes of declines, the first step is to establish the habitat data requirements needed to accomplish this.

4.2   Plans for continuing the targeted Scottish Woodland Breeding Bird Survey

One of the original aims of the Scottish Woodland Bird Survey project was to phase in recruitment of volunteers to take over new sites surveyed by professional fieldworkers in the second and third years of the project. Although core BBS survey coverage in Scotland suffers in many areas due to lack of sufficient numbers of volunteers and the remote nature of many of the random sites, we hoped that the capacity to offer potential volunteers an additional set of 1 km squares, targeted at woodland and hence potentially less remote than some of the upland areas, would increase the likelihood of uptake. In 2007 we established and surveyed an initial core of 83 sites (including some with adjacent squares surveyed) in the new scheme. From 2008 onward, we provided lists of the additional squares in each region to local BBS Regional Organisers with instructions to recruit as many volunteers as possible. In the meantime, we attempted to insure against possible low volunteer recruitment by employing the professional fieldworkers to survey more sites than in the proposal, in order to survey as many of the uncovered squares as possible, to maintain the sample.

Uptake of the new survey squares by volunteers was much less than hoped, and in the third year of the project (2009), still only a small proportion of the original new sites were being surveyed by volunteers, despite considerable effort to encourage recruitment through the BTO's regional network. The main reason for poor rates of square take-up is obvious. The second and third years of the Scottish Woodland Bird Survey project coincided with one of the largest volunteer bird surveying initiatives in the past 20 years – the BTO/BWI/SOC Bird Atlas 2007-11 which aims to cover all 10 km squares in Scotland once between the years 2008 and 2011. Organised in Scotland by BTO, and relying heavily on the efforts of the volunteer regional networks of bird surveyors, this has left few

surveyors to take on new BBS squares and indeed, core BBS has experienced declines in coverage over the last two years. Achieving good atlas coverage in Scotland was always going to be a challenge, but although this has limited the availability of new volunteers during this phase of the Scottish Woodland Bird Survey project, we expect that the atlas project will have an overall positive effect on recruitment for BBS (both core squares and the additional woodland squares). We expect coverage to improve post-Atlas in 2012, with a much larger pool of motivated and experienced bird surveyors to draw upon. It is also worth highlighting that the new atlas will provide invaluable comprehensive information on the spatial and temporal distribution of all woodland bird species in Scotland, updating information from 1990 and making it feasible to generate other measures of woodland bird status.

Following the end of funding for this project in March 2010, the BTO has continued to promote volunteer take-up of these sites through the Regional Network (albeit still in the context of potential competition for surveyors for the atlas in 2010 and 2011). Volunteer recruitment is done mainly through the BTO's Regional Representatives, who are in charge of finding volunteers to take up BBS squares, as well as for other initiatives. The Regional Representatives are best placed to assess volunteer capacity for different surveys and allocate effort in their region, and hence it is essential to work closely with them. We will also explore other opportunities to recruit new volunteers by promoting the survey results in the BBS reports, emails, articles in birding media and through our BTO Scotland office.

4.3 Evaluation of aim to increase capacity to report on woodland bird species in Scotland

The primary aim of the Scottish Woodland Bird Survey project was to increase capacity to monitor a a suite of woodland bird species, particularly those that could not be incorporated into the Terrestrial Breeding Birds Indicator for Scotland because data from the core BBS were insufficient for this purpose. At the time of the 2006 scoping review, we compiled a list of 15 species detected too infrequently on BBS squares in Scotland for reliable trends to be generated. These included Great Spotted Woodpecker, Chiffchaff, Tree Pipit, Blackcap, Bullfinch, Treecreeper, Jay, Common Crossbill, Long-tailed Tit, Wood Warbler, Garden Warbler, Redstart, Sparrowhawk, Green Woodpecker and Spotted Flycatcher. Of these, it was thought that target sampling of ca 100 wooded sites using standard BBS methods would increase sample sizes enough to be able to calculate trends for many of these species, depending on whether sites were targeted at woodland in general or either broad-leaved or coniferous woodland. As the initial number of squares in the woodland bird survey was reduced to ca 80 (to fit within budget), a slight reduction in its efficacy would be expected. Expectations for species coverage were formally re-evaluated following the first year of results (in 2007) by summing: (i) the current average sample size for each species and (ii) the expected increase in the sample based on the number of Scottish Woodland BBS squares occupied by the target species in the first year of the project. Where the sum of these two figures exceeded 30, it was predicted that sufficient data would be collected through the additional sampling to be able to monitor the species effectively and for the species to be added to the Terrestrial Breeding Birds Indicator for Scotland (see Table 10). This resulted in the prediction that 8 species (Chiffchaff, Great Spotted Woodpecker, Treecreeper, Tree Pipit, Common Crossbill, Sparrowhawk, Long-tailed Tit and Spotted Flycatcher) would be able to be added to the list of monitored species, if the species abundance remained at current levels. Two other species (Blackcap and Bullfinch) for which the additional coverage was needed, had already reached the 30 square threshold by 2007, due to increases in core BBS survey coverage in Scotland.

Since the scoping study in 2006, and by incorporating results from the Scottish Woodland BBS into population trends for woodland species in Scotland, six woodland specialists (Blackcap, Bullfinch, Treecreeper, Tree Pipit, Chiffchaff and Great Spotted Woodpecker) were added to the woodland species list in the Terrestrial Breeding Birds Indicator for Scotland (see Table 10). This increase in the species list is the combined result of: (i) inclusion of the additional data from this project, and (ii) continued growth of the BBS in Scotland, growing from <300 annually-surveyed squares between 1999 and 2004 to a peak of 413 in 2007 (note, however, that the number of core BBS squares

surveyed has since fallen to ca 330 in 2008 and 2009). Moreover, the mean sample size for many non-target woodland species has been considerably augmented, making trends more robust, less susceptible to the effects of subsequent declines in the species, and allowing for further breakdowns by region or habitat.

It should be noted that the chance of achieving a sufficient sample of occupied sites to monitor the scarcest of woodland species in the original long list (such as Jay, Garden Warbler, Wood Warbler Redstart and Green Woodpecker) was always very low and the reduction of the original sample from ca 100 to ca 80 squares would have made this more difficult. Most of these species are encountered too infrequently, even incorporating the additional sites, to be able to generate reliable trends.

Nevertheless, despite the successes for six species, we failed to achieve the critical sampling threshold for four species for which we predicted success following the results from the first year, namely Spotted Flycatcher, Long-tailed Tit, Sparrowhawk and Common Crossbill (see Table 10).

There are a number of possible reasons for this failure. Firstly, many of the target species have declined significantly in numbers in recent years. In particular, migrant species such as Spotted Flycatcher, as well as the scarcer Wood Warbler and Garden Warbler, are in steep decline across the UK (including in Scotland although the evidence for Scottish trends is sparse) and hence the increase in sampling effort achieved by this project has been largely cancelled out by overall reductions in their numbers. This is evident in the clear disappearance of Spotted Flycatchers from the Scottish Woodland Breeding Bird survey sites since 2007 (see Table 10). Similarly, although there is little evidence that Common Crossbills are in overall decline, numbers of this irruptive species varied considerably between years, being particularly low in 2009, and hindering our capacity to detect enough occupied sites to generate a population trend for this species in Scotland. With further years of data, the situation for this species may change if numbers increase again.

Secondly, since additional survey effort was distributed randomly, albeit on sites with some woodland, across all of Scotland (reflecting the diverse array of the target species) there was no focus on sites in the south where more lowland and/or southerly-distributed species such as Jay, Chiffchaff or Garden Warbler were likely to occur (see Figure 1).

Lastly is the issue of critical threshold which is both a problem but also provides an alternative solution. As for routine BBS reporting, we use a minimum threshold of 30 sites (this is the average number of occupied sites in the model over the whole period) for deciding whether to include the species in reports and in indicators. This means that although a large increase in sample size in part of a time series (between 2007 and 2009 in this case) will increase the average, the overall mean will still be affected by the smaller samples during the earlier years (1994 to 2006). In time, if the Scottish Woodland BBS sites continue to be surveyed, the 'mean' will grow. However, it may be worth considering an alternative option. This would be to generate trends for some borderline species (such as Common Crossbill, Sparrowhawk, Long-tailed Tit and Spotted Flycatcher) covering only the period from which survey effort is sufficient to generate an index, i.e. from 2007 to the latest available year of data. Over this period, the mean sample size would be considerably greater than if it were based on the entire period since 1994 for the reasons explained above. It might then be possible to report shorter-term trends for these species and to bring these species into bird indicators in the year 2007, the year at which a trend became possible to generate. There are already protocols for adding woodland species such as Siskin, Nightingale and Wood Warbler to the UK and English multi-species indicators, from 1994 – the year when BBS started to provide reliable trends for these species, and this might be an option for development of the woodland bird indicator in Scotland. It should be noted that these procedures do introduce further complications in generating population trends and the costs and benefits would need to be considered carefully. Careful use of caveats for identifying sub-periods in population trajectories where the mean sample size is lower than the critical threshold is another possibility. At this stage, a trend calculated using this method would also be very short (2007 to 2009) and it might be worth reconsidering options after the next couple of years to see how well the level of the coverage of additional Scottish Woodland Breeding Bird Survey squares is maintained, in light of

possible further increases in core BBS coverage in Scotland, especially post-atlas, and in changes in numbers of many of these Scottish species due to a wide range of factors, including climate and land use change.

5. CONCLUSIONS AND RECOMMENDATIONS

Overall, the project was broadly successful with the target of surveying at least 80 sites achieved in 2007 (when 83 sites were surveyed) and falling slightly to 74 sites in 2009. However, this was achieved by maintaining a higher level of professional coverage than anticipated to make up for poor recruitment of volunteers during this period. The additional coverage of sites occupied by woodland birds achieved through this process resulted directly in the addition of four species to the Scottish woodland bird indicator, but the critical sampling threshold was not yet achieved for four other target species, namely Spotted Flycatcher, Long-tailed Tit, Sparrowhawk and Common Crossbill.

A BTO-hosted workshop to tackle the issue of increasing BBS coverage in remote regions and landscapes is being planned for January 2011. This will include discussion sessions dealing with the issues of how we can improve our capacity to monitor species currently not detected on enough squares, how coverage in individual habitats, countries and regions can be improved and ways to engage more volunteers. The experience and results of the Scottish Woodland BBS project between 2007 and 2009 will provide a case example of how this can be done, and much scope for further discussions, including the limitations of such approaches and how these could be overcome. In the meantime, the Scottish Woodland BBS results have been integrated into the generation of population trends for woodland birds in Scotland and although there were no professional fieldworkers in 2010, volunteer coverage is continuing to be sought for all 83 sites covered between 2007 and 2009.

To date, no detailed work to test the relationship between the numbers of birds and various habitat characteristics has been carried out with BBS or Scottish Woodland BBS data, and the supplementary habitat data collected on a subset of squares is likely to be of limited value. However, exploratory analyses could be conducted to examine how such factors as the type and age of woodland, area of woodland, dominant tree species, relate to the presence, number of species and relative densities of birds within squares. Investigations of the effects of features such as tree species composition or amount of deadwood will require further bespoke data collection and might best be achieved through more intensive studies on forest features and bird abundance, at smaller scales.

Table 10. Evaluation of successes and failures in attaining the critical sample size thresholds for species in the target list.

	Mean sample (1994-2006) (# woodland sqs)	Predicted to attain 30 square threshold	Mean sample (1994-2009) (without SW sqs)	Mean sample (1994-2009) (with SW sqs)	# SW sites occupied in 2007 (N=83)	# SW sites occupied in 2008 (N=71)	# SW sites occupied in 2009 (N=74)	Reporting in BBS and Indicator possible
Blackcap	35 (30)	Included 06	42	48	32	27	23	Included
Bullfinch	31 (23)	Included 06	33	37	29	12	13	Included
Chiffchaff	28 (28)	Y	36	40	19	16	27	Included
Great Spotted Woodpecker	26 (24)	Y	35	41	27	31	30	Included
Treecreeper	28 (23)	Y	31	35	23	24	17	Included
Tree Pipit	24 (20)	Y	26	32	29	24	25	Included
Common Crossbill	15 (14)	Y	17	23	28	42	12	No
Sparrowhawk	18 (9)	Y	19	21	13	7	3	No
Long-tailed Tit	22 (20)	Y	25	27	16	16	7	No
Spotted Flycatcher	21 (13)	Y	21	23	12	3	1	No
Jay	12 (n/a)	No	14	17	14	13	14	No
Garden Warbler	18 (14)	No	20	21	5	4	4	No
Redstart	11 (8)	No	11	12	4	3	3	No
Green Woodpecker	7 (n/a)	No	7	7	5	1	1	No

Acknowledgements

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Species name	All species		Woodland		Farmland		Upland	
	94-08	07-08	94-08	07-08	94-08	07-08	94-08	07-08
Great Spotted Woodpecker	494	32	494	32				
Chiffchaff	446	47	446	47				
Stonechat	215	-4						
Corncrake	181	11			181	11		
House Martin	146	-9						
Grey Heron	132	-4						
Goldfinch	127	23			182	16		
Grey Wagtail	126	30						
Blackcap	114	-2	156	16				
Goldcrest	111	18	111	18				
Wren	102	7	102	7				
Snipe	94	27					94	27
Capercaillie	92	13	92	13				
Bullfinch	91	-4	91	-4				
Treecreeper	91	11	91	11				
Great Tit	89	3	68	-8	119	-10		
Reed Bunting	81	13			81	13		
Whitethroat	80	-2			80	-2		
Hen Harrier	76	6					76	6
Siskin	69	41	69	41				
Raven	61	-43					61	-43
Buzzard	56	7	43	24	69	8		
Dunnock	53	16	46	-16	23	14		
Sedge Warbler	49	17			49	17		
Tree Pipit	48	-14	48	-14				
House Sparrow	46	9						
Cuckoo	41	-9	3	-4			124	45
Willow Warbler	41	4	41	4				
Magpie	33	13			33	33		
Song Thrush	32	3	25	-3	81	16		
Greenfinch	31	15			25	24		
Coal Tit	27	23	27	23				
Swallow	26	14			26	14		
Jackdaw	25	5			-3	-20		
Linnet	24	4			24	4		
Mistle Thrush	20	-14	20	-14				
Red Grouse	20	5					20	5
Starling	19	24			19	28		
Blackbird	18	-6	4	-12	28	-5		
Blue Tit	14	-10	10	1	19	-6		
Robin	12	7	22	7				
Pied Wagtail	9	0			9	0		
Mallard	6	1						
Chaffinch	5	-2	6	-8	3	-9		
Skylark	4	4			0	6	18	-1
Lesser Redpoll	4	18	4	18				
Golden Eagle	3	0					3	0
Yellowhammer	2	-14			2	-14		
Woodpigeon	2	19			-9	7		

Species name	All species		Woodland		Farmland		Upland	
	94-08	07-08	94-08	07-08	94-08	07-08	94-08	07-08
Wheatear	1	-5					1	-5
Carrion Crow	-5	-18			-1	-20		
Meadow Pipit	-14	8					-14	8
Peregrine	-15	-1					-15	-1
Lapwing	-19	19			-19	19		
Oystercatcher	-22	8			-22	8		
Rook	-24	-20			-24	-20		
Collared Dove	-25	-18						
Kestrel	-29	45			-29	45		
Common Sandpiper	-30	-10					-30	-10
Hooded Crow	-31	14					-31	14
Dipper	-37	-22					-37	-22
Black Grouse	-37	-3					-37	-3
Golden Plover	-40	-32					-40	-32
Curlew	-45	0					-45	0
Swift	-57	-20						

Appendix 2. Species observed in Scottish Woodland Bird Surveys 2007 to 2009. Species are listed in alphabetical order.

Species	2007	2008	2009
Barn Owl	Present	Present	Present
Black Grouse	Present	Present	Present
Blackbird	Present	Present	Present
Blackcap	Present	Present	Present
Black-headed Gull	Present	Present	Present
Black-throated Diver	Present		
Blue Tit	Present	Present	Present
Brambling	Present		
Bullfinch	Present	Present	Present
Buzzard	Present	Present	Present
Canada Goose	Present	Present	Present
Carrion Crow	Present	Present	Present
Cetti's Warbler	Present		
Chaffinch	Present	Present	Present
Chiffchaff	Present	Present	Present
Coal Tit	Present	Present	Present
Collared Dove	Present	Present	Present
Crossbill	Present	Present	Present
Common Gull	Present	Present	Present
Common Sandpiper	Present	Present	Present
Coot	Present	Present	Present
Cormorant		Present	Present
Corn Bunting	Present		
Crested Tit	Present	Present	
Cuckoo	Present	Present	Present
Curlew	Present	Present	Present
Dipper	Present	Present	Present
Domestic-type goose			Present
Dunnock	Present	Present	Present
Feral Pigeon		Present	Present
Fieldfare		Present	Present
Fulmar	Present		
Gannet			Present
Garden Warbler	Present	Present	Present
Goldcrest	Present	Present	Present
Golden Pheasant		Present	Present
Golden Plover	Present	Present	Present
Goldeneye	Present	Present	
Goldfinch	Present	Present	Present
Goosander		Present	Present
Goshawk		Present	
Grasshopper Warbler	Present	Present	Present
Great Black-backed Gull	Present		Present
Great Spotted Woodpecker	Present	Present	Present
Great Tit	Present	Present	Present
Green Woodpecker	Present	Present	Present
Greenfinch	Present	Present	Present
Greenshank	Present		
Grey Heron	Present	Present	Present
Grey Partridge	Present		

Species	2007	2008	2009
Grey Wagtail	Present	Present	Present
Greylag Goose	Present	Present	Present
Hawfinch	Present		
Hen Harrier	Present		
Herring Gull	Present	Present	Present
Hooded Crow	Present	Present	Present
House Martin	Present	Present	Present
House Sparrow	Present	Present	Present
Jackdaw	Present	Present	Present
Jay	Present	Present	Present
Kestrel	Present	Present	Present
Lapwing	Present	Present	Present
Lesser Black-backed Gull	Present	Present	Present
Lesser Redpoll	Present	Present	Present
Lesser Spotted Woodpecker	Present		Present
Lesser Whitethroat	Present		Present
Linnet	Present	Present	Present
Little Grebe			Present
Long-tailed Tit	Present	Present	Present
Magpie	Present	Present	Present
Mallard	Present	Present	Present
Marsh Harrier			Present
Marsh Tit	Present	Present	Present
Meadow Pipit	Present	Present	Present
Merlin	Present		
Mistle Thrush	Present	Present	Present
Moorhen	Present	Present	Present
Mute Swan	Present	Present	Present
Nuthatch	Present	Present	Present
Osprey	Present	Present	Present
Oystercatcher	Present	Present	Present
Peregrine		Present	
Pheasant	Present	Present	Present
Pied Flycatcher	Present	Present	Present
Pied Wagtail	Present	Present	Present
Pink-footed Goose	Present	Present	Present
Raven	Present	Present	Present
Red Grouse	Present	Present	Present
Red Kite	Present		
Red-breasted Merganser	Present	Present	
Red-legged Partridge	Present	Present	Present
Redshank	Present	Present	Present
Redstart	Present	Present	Present
Red-throated Diver	Present		
Redwing			Present
Reed Bunting	Present	Present	Present
Reed Warbler	Present		
Ring Ouzel	Present		Present
Ringed Plover	Present		
Robin	Present	Present	Present
Rook	Present	Present	Present
Sand Martin	Present	Present	Present
Sanderling	Present		

Species	2007	2008	2009
Sedge Warbler	Present	Present	Present
Shag	Present		
Shelduck	Present		
Short-eared Owl			Present
Siskin	Present	Present	Present
Skylark	Present	Present	Present
Snipe	Present	Present	Present
Song Thrush	Present	Present	Present
Sparrowhawk	Present	Present	Present
Spotted Flycatcher	Present	Present	Present
Starling	Present	Present	Present
Stock Dove			Present
Stonechat	Present	Present	Present
Swallow	Present	Present	Present
Swift	Present	Present	Present
Tawny Owl	Present	Present	
Teal	Present	Present	Present
Tree Pipit	Present	Present	Present
Tree Sparrow	Present		Present
Treecreeper	Present	Present	Present
Tufted Duck	Present	Present	Present
Twite	Present	Present	
Wheatear	Present	Present	Present
Whinchat	Present	Present	Present
Whitethroat	Present	Present	Present
Whooper Swan		Present	
Wigeon		Present	Present
Willow Tit	Present		
Willow Warbler	Present	Present	Present
Wood Pigeon	Present	Present	Present
Wood Warbler	Present	Present	Present
Woodcock	Present	Present	Present
Wren	Present	Present	Present
Yellow Wagtail	Present		
Yellowhammer	Present	Present	Present

Appendix 3.   Results based on all 1-km squares surveyed (i.e. main and adjacent squares analysed in combination).

Table 11.   Measures of abundance on all sites (main and adjacent 1 km squares) in 2009.

Species	Occurrence on all Scottish woodland squares (n=106)	Abundance on all Scottish woodland squares (n=106)	Abundance on occupied Scottish Woodland squares
Chaffinch	1 (106)	18 +/- 0.96	18 +/- 0.96
Willow Warbler	0.99 (105)	12.15 +/- 0.87	12.27 +/- 0.87
Wren	0.97 (103)	8.85 +/- 0.48	9.11 +/- 0.47
Robin	0.96 (102)	7.25 +/- 0.46	7.54 +/- 0.46
Song Thrush	0.92 (97)	2.58 +/- 0.19	2.81 +/- 0.19
Siskin	0.88 (93)	5.45 +/- 0.47	6.22 +/- 0.49
Coal Tit	0.86 (91)	5.92 +/- 0.51	6.9 +/- 0.53
Wood Pigeon	0.83 (88)	12.88 +/- 2.15	15.51 +/- 2.5
Blackbird	0.71 (75)	2.47 +/- 0.31	3.49 +/- 0.38
Goldcrest	0.65 (69)	2.14 +/- 0.32	3.29 +/- 0.43
Carrion Crow	0.62 (66)	3.2 +/- 0.43	5.14 +/- 0.57
Great Tit	0.62 (66)	1.75 +/- 0.21	2.8 +/- 0.27
Meadow Pipit	0.58 (61)	3.99 +/- 0.72	6.93 +/- 1.11
Buzzard	0.54 (57)	0.88 +/- 0.1	1.63 +/- 0.11
Dunnock	0.54 (57)	1.33 +/- 0.16	2.47 +/- 0.21
Swallow	0.51 (54)	2.05 +/- 0.34	4.02 +/- 0.55
Blue Tit	0.5 (53)	1.77 +/- 0.26	3.55 +/- 0.4
Mistle Thrush	0.49 (52)	0.85 +/- 0.11	1.73 +/- 0.15
Pheasant	0.46 (49)	2.1 +/- 0.36	4.55 +/- 0.62
Lesser Redpoll	0.42 (44)	1.24 +/- 0.23	2.98 +/- 0.43
Pied Wagtail	0.41 (43)	0.73 +/- 0.1	1.79 +/- 0.14
Skylark	0.38 (40)	1.59 +/- 0.34	4.23 +/- 0.74
Great Spotted Woodpecker	0.35 (37)	0.55 +/- 0.09	1.57 +/- 0.15
Tree Pipit	0.34 (36)	0.77 +/- 0.14	2.28 +/- 0.29
Chiffchaff	0.33 (35)	0.63 +/- 0.13	1.91 +/- 0.27
Cuckoo	0.33 (35)	0.43 +/- 0.07	1.31 +/- 0.1
Blackcap	0.32 (34)	0.55 +/- 0.11	1.71 +/- 0.24
Oystercatcher	0.3 (32)	0.89 +/- 0.17	2.94 +/- 0.37
Jackdaw	0.27 (29)	2.23 +/- 0.87	8.14 +/- 2.94
Curlew	0.25 (27)	0.8 +/- 0.21	3.15 +/- 0.63
Jay	0.22 (23)	0.32 +/- 0.07	1.48 +/- 0.12
Bullfinch	0.21 (22)	0.3 +/- 0.06	1.45 +/- 0.13
Treecreeper	0.21 (22)	0.42 +/- 0.09	2.05 +/- 0.21
Common Crossbill	0.17 (18)	0.47 +/- 0.16	2.78 +/- 0.76
Long-tailed Tit	0.07 (7)	0.15 +/- 0.07	2.29 +/- 0.64
Wood Warbler	0.07 (7)	0.09 +/- 0.04	1.43 +/- 0.43
Garden Warbler	0.06 (6)	0.08 +/- 0.03	1.33 +/- 0.21
Redstart	0.05 (5)	0.08 +/- 0.04	1.8 +/- 0.58
Spotted Flycatcher	0.05 (5)	0.07 +/- 0.03	1.4 +/- 0.24
Sparrowhawk	0.04 (4)	0.04 +/- 0.02	1 +/- 0
Green Woodpecker	0.02 (2)	0.02 +/- 0.01	1 +/- 0
Crested Tit	0	n/a	n/a

Note: Occurrence rate (and numbers of squares in which species were detected) and abundance of individual species on all 106 Scottish woodland survey squares (main and adjacent) in 2009. [Ranked in order of occurrence. Only species defined as target woodland species in the proposal (those in **bold**), or that have a higher than 0.25 occurrence rate on the main Scottish woodland surveyed squares are presented]

Table 12.　　　　　Comparison of occurrence rates on all squares (main and adjacent summed) between years.

	Occurrence rate 2007	Occurrence rate 2008	Occurrence rate 2009	Significant inter-annual effect
Robin	1 (96)	0.99 (95)	0.96 (92)	
Wren	1 (96)	1 (96)	0.97 (93)	
Chaffinch	0.99 (95)	0.99 (95)	1 (96)	
Willow Warbler	0.99 (95)	0.96 (92)	0.99 (95)	
Song Thrush	0.93 (89)	0.91 (87)	0.91 (87)	
Coal Tit	0.88 (84)	0.86 (83)	0.86 (83)	
Goldcrest	0.85 (82)	0.88 (84)	0.66 (63)	***
Wood Pigeon	0.8 (77)	0.8 (77)	0.82 (79)	
Blackbird	0.74 (71)	0.75 (72)	0.72 (69)	
Blue Tit	0.71 (68)	0.56 (54)	0.51 (49)	*
Siskin	0.71 (68)	0.81 (78)	0.88 (84)	*
Meadow Pipit	0.65 (62)	0.59 (57)	0.61 (59)	
Great Tit	0.64 (61)	0.73 (70)	0.65 (62)	
Buzzard	0.59 (57)	0.67 (64)	0.54 (52)	
Carrion Crow	0.58 (56)	0.58 (56)	0.61 (59)	
Dunnock	0.53 (51)	0.61 (59)	0.51 (49)	
Pheasant	0.53 (51)	0.54 (52)	0.47 (45)	
Swallow	0.47 (45)	0.44 (42)	0.5 (48)	
Lesser Redpoll	0.45 (43)	0.43 (41)	0.43 (41)	
Skylark	0.44 (42)	0.41 (39)	0.38 (36)	
Crossbill	0.41 (39)	0.57 (55)	0.18 (17)	***
Mistle Thrush	0.41 (39)	0.33 (32)	0.51 (49)	*
Pied Wagtail	0.41 (39)	0.35 (34)	0.39 (37)	
Tree Pipit	0.36 (35)	0.33 (32)	0.33 (32)	
Cuckoo	0.35 (34)	0.35 (34)	0.31 (30)	
Curlew	0.34 (33)	0.36 (35)	0.27 (26)	
Blackcap	0.32 (31)	0.33 (32)	0.3 (29)	
Bullfinch	0.31 (30)	0.18 (17)	0.21 (20)	
Grey Wagtail	0.31 (30)	0.23 (22)	0.22 (21)	
Oystercatcher	0.31 (30)	0.38 (36)	0.31 (30)	
Mallard	0.29 (28)	0.15 (14)	0.17 (16)	
Treecreeper	0.29 (28)	0.25 (24)	0.22 (21)	
Stonechat	0.28 (27)	0.19 (18)	0.17 (16)	
Great Spotted Woodpecker	0.27 (26)	0.42 (40)	0.35 (34)	
Greenfinch	0.27 (26)	0.22 (21)	0.22 (21)	
Goldfinch	0.26 (25)	0.23 (22)	0.22 (21)	
Spotted Flycatcher	0.18 (17)	0.03 (3)	0.04 (4)	***
Chiffchaff	0.17 (16)	0.24 (23)	0.3 (29)	
Long-tailed Tit	0.17 (16)	0.15 (14)	0.04 (4)	*
Sparrowhawk	0.15 (14)	0.08 (8)	0.04 (4)	*
Jay	0.14 (13)	0.17 (16)	0.2 (19)	
Wood Warbler	0.11 (11)	0.07 (7)	0.07 (7)	
Garden Warbler	0.06 (6)	0.06 (6)	0.05 (5)	
Green Woodpecker	0.06 (6)	0.06 (6)	0.05 (5)	
Redstart	0.06 (6)	0.06 (6)	0.05 (5)	
Crested Tit	0.03 (3)	0.01 (1)	n/a	

Note: The occurrence rate of individual species (and numbers of squares in which species were detected), in order of occurrence, on main and adjacent Scottish woodland squares surveyed every years from 2007 to 2009. Only species defined as target woodland species (those in bold), or that have a higher than 0.25 occurrence rate on the Scottish woodland survey squares are presented. Significant differences among years coded as follows: * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.0001$

Table 13　　Comparison of relative abundance on all squares (main and adjacent summed) between years.

	Abundance 2007	Abundance 2008	Abundance 2009	Significant inter-annual effects
Robin	8.27 +/- 0.56	9.15 +/- 0.64	7.28 +/- 0.5	
Wren	13.19 +/- 0.97	14.66 +/- 1.26	8.68 +/- 0.52	***
Chaffinch	16.82 +/- 1.22	19.19 +/- 1.59	18.49 +/- 1.04	
Willow Warbler	10.58 +/- 0.9	11.2 +/- 0.95	12.17 +/- 0.92	
Song Thrush	2.83 +/- 0.2	2.81 +/- 0.26	2.45 +/- 0.18	
Coal Tit	6.6 +/- 0.64	7.77 +/- 0.85	5.91 +/- 0.53	
Goldcrest	5.86 +/- 0.59	6.71 +/- 0.75	2.28 +/- 0.35	***
Wood Pigeon	7.33 +/- 1.22	10.66 +/- 1.47	12.48 +/- 2.16	***
Blackbird	2.82 +/- 0.38	2.85 +/- 0.43	2.29 +/- 0.27	
Blue Tit	2.68 +/- 0.34	2.13 +/- 0.32	1.77 +/- 0.27	*
Siskin	6.58 +/- 0.9	8.71 +/- 0.94	5.42 +/- 0.49	
Meadow Pipit	4.77 +/- 0.61	4.45 +/- 0.71	4.15 +/- 0.77	
Great Tit	2.22 +/- 0.28	2.89 +/- 0.34	1.79 +/- 0.22	
Buzzard	0.97 +/- 0.11	1.08 +/- 0.11	0.9 +/- 0.1	
Carrion Crow	3.76 +/- 0.67	3.73 +/- 0.56	3.22 +/- 0.46	
Dunnock	1.22 +/- 0.16	1.61 +/- 0.22	1.21 +/- 0.16	
Pheasant	1.78 +/- 0.25	2.43 +/- 0.36	2.16 +/- 0.38	
Swallow	1.49 +/- 0.23	1.56 +/- 0.31	1.84 +/- 0.31	
Lesser Redpoll	1.33 +/- 0.21	1.91 +/- 0.33	1.16 +/- 0.21	
Skylark	1.79 +/- 0.31	2.21 +/- 0.52	1.6 +/- 0.37	
Crossbill	1.85 +/- 0.37	3.84 +/- 1.01	0.51 +/- 0.18	**
Mistle Thrush	0.79 +/- 0.12	0.54 +/- 0.09	0.9 +/- 0.12	
Pied Wagtail	0.58 +/- 0.08	0.58 +/- 0.09	0.65 +/- 0.1	
Tree Pipit	0.88 +/- 0.19	0.69 +/- 0.13	0.74 +/- 0.15	
Cuckoo	0.53 +/- 0.09	0.44 +/- 0.07	0.41 +/- 0.07	
Curlew	0.78 +/- 0.22	1.06 +/- 0.25	0.86 +/- 0.23	
Blackcap	0.71 +/- 0.15	0.53 +/- 0.09	0.42 +/- 0.08	*
Bullfinch	0.58 +/- 0.11	0.32 +/- 0.08	0.31 +/- 0.07	**
Grey Wagtail	0.48 +/- 0.09	0.45 +/- 0.11	0.41 +/- 0.09	
Oystercatcher	0.74 +/- 0.16	1.07 +/- 0.2	0.96 +/- 0.19	
Mallard	1.19 +/- 0.41	0.52 +/- 0.18	0.58 +/- 0.15	**
Treecreeper	0.64 +/- 0.13	0.5 +/- 0.11	0.46 +/- 0.1	
Stonechat	0.58 +/- 0.11	0.35 +/- 0.09	0.29 +/- 0.08	**
Great Spotted Woodpecker	0.4 +/- 0.08	0.59 +/- 0.09	0.53 +/- 0.09	
Greenfinch	0.64 +/- 0.18	0.49 +/- 0.12	0.45 +/- 0.11	
Goldfinch	0.54 +/- 0.12	0.55 +/- 0.13	0.48 +/- 0.11	
Spotted Flycatcher	0.21 +/- 0.05	0.04 +/- 0.03	0.06 +/- 0.03	***
Chiffchaff	0.34 +/- 0.11	0.47 +/- 0.11	0.54 +/- 0.12	
Long-tailed Tit	0.57 +/- 0.2	0.33 +/- 0.09	0.11 +/- 0.07	***
Sparrowhawk	0.15 +/- 0.04	0.08 +/- 0.03	0.04 +/- 0.02	***
Jay	0.19 +/- 0.06	0.24 +/- 0.06	0.28 +/- 0.06	
Wood Warbler	0.18 +/- 0.06	0.1 +/- 0.04	0.1 +/- 0.05	
Garden Warbler	0.14 +/- 0.07	0.09 +/- 0.04	0.07 +/- 0.03	
Green Woodpecker	0.11 +/- 0.06	0.08 +/- 0.04	0.09 +/- 0.05	
Redstart	0.11 +/- 0.06	0.08 +/- 0.04	0.09 +/- 0.05	
Crested Tit	0.08 +/- 0.05	0.02 +/- 0.02	n/a	**

Note: The mean abundance ± s.e of species across all squares (n=96) of Scottish woodland main and adjacent squares surveyed every years from 2007 to 2009. Only species defined as target woodland species in the proposal (those in bold), or that have a higher than 0.25 occurrence rate on the main Scottish woodland surveyed squares are presented. Significant differences among years coded as follows: * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.0001$

Table 14   Comparison of relative abundance on occupied squares (main and adjacent summed) between years.

Species	Abundance 2007 (n=91)	Abundance 2008 (n=91)	Abundance 2009 (n=91)	Significant inter-annual effects
Chaffinch	17.2 ± 1.28	19.63 ± 1.65	18.73 ± 1.01	*
Willow Warbler	10.71 ± 0.94	11.7 ± 1.03	12.34 ± 0.94	**
Robin	8.47 ± 0.58	9.79 ± 0.67	7.81 ± 0.51	
Wren	13.16 ± 1.02	15.41 ± 1.3	9.25 ± 0.51	***
Song Thrush	3.1 ± 0.21	3.08 ± 0.27	2.72 ± 0.19	
Coal Tit	7.61 ± 0.69	9.18 ± 0.93	6.7 ± 0.52	*
Siskin	9.64 ± 1.17	10.79 ± 1	6.21 ± 0.53	***
Wood Pigeon	9.35 ± 1.55	13.57 ± 1.87	15.77 ± 2.68	***
Blackbird	3.95 ± 0.48	3.94 ± 0.56	3.08 ± 0.32	**
Goldcrest	6.99 ± 0.65	7.9 ± 0.83	3.49 ± 0.47	***
Great Tit	3.6 ± 0.37	3.9 ± 0.39	2.8 ± 0.27	*
Carrion Crow	6.75 ± 1.07	6.58 ± 0.83	5.43 ± 0.64	**
Meadow Pipit	7.03 ± 0.75	7.04 ± 0.98	6.82 ± 1.21	
Buzzard	1.6 ± 0.11	1.65 ± 0.11	1.65 ± 0.12	
Dunnock	2.34 ± 0.23	2.59 ± 0.27	2.38 ± 0.22	
Mistle Thrush	1.92 ± 0.16	1.62 ± 0.14	1.77 ± 0.16	
Blue Tit	3.8 ± 0.43	3.69 ± 0.34	3.49 ± 0.42	
Swallow	3.16 ± 0.35	3.32 ± 0.52	3.64 ± 0.5	
Pheasant	3.36 ± 0.36	4.58 ± 0.53	4.34 ± 0.61	*
Lesser Redpoll	2.88 ± 0.32	4.59 ± 0.58	2.74 ± 0.4	
Pied Wagtail	1.45 ± 0.1	1.67 ± 0.13	1.69 ± 0.14	
Skylark	4.05 ± 0.56	4.62 ± 0.93	4.09 ± 0.84	
Great Spotted Woodpecker	1.46 ± 0.15	1.45 ± 0.11	1.52 ± 0.15	
Tree Pipit	2.48 ± 0.44	2.03 ± 0.25	2.26 ± 0.32	
Blackcap	2.19 ± 0.33	1.72 ± 0.18	1.38 ± 0.14	**
Chiffchaff	2.13 ± 0.54	2.05 ± 0.31	1.79 ± 0.3	
Cuckoo	1.55 ± 0.15	1.25 ± 0.1	1.31 ± 0.11	
Oystercatcher	2.38 ± 0.4	3.09 ± 0.45	2.9 ± 0.35	
Curlew	2.26 ± 0.61	3 ± 0.63	3.08 ± 0.67	
Treecreeper	2.18 ± 0.27	1.91 ± 0.24	2.1 ± 0.22	
Bullfinch	1.88 ± 0.22	1.88 ± 0.22	1.47 ± 0.14	
Jay	1.38 ± 0.21	1.5 ± 0.18	1.42 ± 0.14	
Crossbill	4.42 ± 0.73	5.3 ± 0.49	2.2 ± 0.45	*
Wood Warbler	1.55 ± 0.25	1.33 ± 0.24	1.43 ± 0.43	
Garden Warbler	2.17 ± 0.65	1.5 ± 0.34	1.4 ± 0.24	
Redstart	2 ± 0.63	1.4 ± 0.4	1.8 ± 0.58	
Long-tailed Tit	3.44 ± 0.91	2.23 ± 0.3	2.75 ± 1.11	
Sparrowhawk	1 ± 0	1 ± 0	1 ± 0	
Spotted Flycatcher	1.18 ± 0.1	1.33 ± 0.33	1.67 ± 0.33	
Green Woodpecker	2 ± 0.37	1 ± 0	1 ± 0	
Crested Tit	2.67 ± 0.67	2 ± 0	-	

Note: The mean abundance ± s.e of species on all occupied squares (main and adjacent) surveyed every year from 2007 to 2009. Only species defined as target woodland species in the proposal (those in bold), or that have a higher than 0.25 occurrence rate on the main Scottish woodland surveyed squares are presented. Significant differences among years coded as follows * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.0001$