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Breeding periods of hedgerow-nesting birds in England

Hugh J. Hanmer & Dave I. Leech

Birds Science People

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A BTO report to Defra

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Executive summary

1. Hedgerows form an important semi-natural habitat for birds and other wildlife in English farmland landscapes, in addition to providing other benefits to farming. They are currently maintained through annual or multi-annual cutting cycles, with management designed to occur outside the bird breeding season and the majority of related activities prohibited from 1st March to 31st August.

2. The aim of this analysis is to assess the impacts on nesting birds should the duration of that prohibited period be reduced, by quantifying the length of the current breeding season for 15 species of songbird likely to nest in farmland hedges (Blackbird, Blackcap, Bullfinch, Chaffinch, Dunnock, Garden Warbler, Goldfinch, Greenfinch, Linnet, Long-tailed Tit, Robin, Song Thrush, Whitethroat, Wren and Yellowhammer), including five species that contribute to the UK Farmland Bird indicator.

3. Two BTO long-term volunteer monitoring datasets provide information on breeding phenology: the Nest Record Scheme (NRS), for which participants record nest histories, and the Ringing Scheme, where laying dates can be inferred from the timing of ringing of nestlings. Comparison of estimates generated using data from the two schemes indicated that the NRS dataset was likely to provide more robust results for this analysis.

4. Laying dates were back-calculated for individual breeding attempts monitored between 2011 and 2021 (omitting 2020) utilising standard NRS analytical methodology. Published information about the length of different stages of the breeding cycle was then used to project the timing of the clutch, brood and dependent fledgling periods for each individual nest.

5. These individual projections were then used to build a composite distribution of nesting phenology for each species across all years; the degree to which this distribution overlaps with four hedgerow management scenarios, specifically i) management permitted from 1st August, ii) from 15th August, iii) as currently, from 1st September and iv) from 15th September, could then be assessed.

6. Nests of 14/15 species still contained eggs or nestlings after 31st July, with the proportion of the annual nest total active at this time highest for Yellowhammer (26%), Bullfinch (10%), Goldfinch (9.9%) and Linnet (9.5%). If active attempts (i.e. those with active nests or dependent fledglings) were considered, these figures rose to 38%, 26%, 16% and 16% respectively.

7. Nests of 11/15 species were still active after 14th August, with the proportion of the annual nest total active at this time highest for Yellowhammer (12%); the respective figure for all other species fell below 10%. The figure for Yellowhammer rose to 28% when attempts with fledged but still dependent young were considered, and exceeded 10% for two other species: Bullfinch (15%) and Linnet (10%).

8. Nests of 6/15 species were still active after 31st August, and therefore potentially at risk under the current regulatory scenario, but the proportion of the annual nest total active in this period did not exceed 1.5% for any species. While 12/15 species were still feeding dependent fledglings at this stage of the season, the proportion of annual attempts that were active in this period did not exceed 10% for any species.

9. Over the 10 years of data analysed, annual variation exhibited in the 95th percentile of the laying date distribution for each species was no greater than +/- one week, indicating limited annual variability in the end of the season over the medium term.

10. Latitudinal and altitudinal variation in the 95th percentile of the laying distribution was of similar magnitude (1–2 weeks) and directionally inconsistent, noting that the power to detect impacts was limited by the relatively small sample sizes at more northerly and more elevated sites.

11. Variability between dominant farmland land-use types was apparently greater, with a two-week difference between 95th percentile estimates generated from subsets of data originating from arable- and grassland-dominated landscapes, but a more robust multivariate analysis would be needed to determine whether habitat type was the driver or whether there were confounding variables at play.

12. Estimates of the end of the season presented here should be treated as conservative due to a combination of observer fatigue and seasonal decreases in nest detectability.

1. Introduction

Hedgerows provide important breeding habitat to a range of generalist species and specialist farmland birds. Hedgerows require management to prevent encroachment onto adjacent agricultural land and landowners are also encouraged to undertake maintenance for environmental services through agri-environment schemes (AES).

Traditionally, hedges were managed through laying or coppicing, generally on decadal cycle, with hedge shape maintained by hand trimming every few years (Staley et al. 2013). Since the 1940s, however, hedgerow cutting and trimming has been carried out predominately using mechanised flails on an annual or multi-annual cycle (Croxton et al. 2004, Staley et al. 2013). This process is likely to have a negative impact on bird breeding success (Fuller 2000), as nests are often located, and fledglings often shelter, towards the outer layers of the hedge where vegetation growth is thickest (Ferguson-Lees et al. 2011), and removal of vegetation is also likely to reduce food availability.

Both active nests and dependent fledglings are protected by law in the UK under the Wildlife and Countryside Act (1981), and farmland hedgerow cutting/trimming is therefore currently prohibited between 1st March and 31st August, to avoid the main bird breeding season and ensure compliance with the GAEC 7a: Boundaries and GAEC 7c: Trees Defra rules. The only exceptions for established hedges are exemptions issued for hedge-laying and coppicing between the 1st March and 30th April, hedge cutting/trimming during August prior to the autumn sowing of oilseed rape or temporary grassland, and the cutting of hedges to prevent the obstruction of highways, roads and footpaths, which can be carried out at any time.

To examine the effectiveness of the current regulations and indicate the potential impact of possible changes in hedgerow management, this report uses monitoring data collected by citizen scientists participating in the BTO/JNCC Nest Record and Ringing Schemes to:

1. provide estimates of the timing of each stage of the nesting cycle for a range of farmland passerine bird species that nest in hedges, with a particular focus on the start and end of the annual breeding period and the subsequent period of parental dependency.
2. quantify the predicted overlap between the nesting/parental dependency periods and the legislated timing of hedgerow management under current and proposed future scenarios, with the exception of the specific, current derogations listed above.

2. Methods and analysis

2.1. Current and potential hedgerow management dates

Hedgerow cutting and trimming is generally not permitted in England between 1st March and 31st August inclusive, covering the primary bird nesting period. 1st August, 15th August and 15th September have all been proposed as potential adjustments to the end of the hedge management suspension period and the key dates of interest highlighted in this report are therefore:

- 1st March (01-Mar, ordinal date 60)
- 1st August (01-Aug, 213)
- 15th August (15-Aug, 227)
- 1st September (01-Sep, 244)
- 15th September (15-Sep, 258)

2.2. Species selection

This report focuses on 15 species that regularly nest in farmland hedges or the herbaceous layer immediately adjacent to them, for which a composite sample of at least 150 nest records of sufficient quality to generate a robust laying date estimate for the individual breeding attempt (see section 2.3.1 and Table 1) had been collected for the Nest Record Scheme over the study period. This suite of species included a) hedge-nesting species that contribute to the UK Farmland Bird indicator (Goldfinch *Carduelis carduelis*, Greenfinch *Chloris chloris*, Linnet *Linaria cannabina*, Whitethroat *Curruca communis* and Yellowhammer *Emberiza citrinella*), and

Table 1. List of focal species, details of breeding ecology and scheme-specific sample sizes. Nesting and ecology details were taken from the BTO BirdFacts site (BTO 2023), with the exception of the maximum parental care period, which was sourced from BirdGuides (2006) and Billerman et al. (2022). For the number of broods, the number(s) outside the parentheses indicates the usual number of breeding attempts (excluding replacements), while the number within the parentheses indicates the maximum number of breeding attempts that could be initiated in optimal conditions. UK Red- and Amber-listed species (Stanbury et al. 2021) are highlighted in those colours and species that contribute to the UK Biodiversity farmland bird indicator are shown in bold (Defra 2022).

		Nesting stage intervals				Species ecology		Scheme sample size	
Species		Mean clutch size/ time until clutch completion	Mean incubation period	Mean nestling period	Maximum parental care period/ post-fledging dependence period	Number of broods	Migratory status	NRS	Pullus ringing
Blackbird	*Turdus merula*	4	13	15	25	2–3 (5)	Resident	4,030	3,649
Blackcap	*Sylvia atricapilla*	5	13	11	21	1–2	Migrant	824	513
Bullfinch	*Pyrrhula pyrrhula*	5	14	16	20	2 (3)	Resident	199	113
Chaffinch	*Fringilla coelebs*	4	12	14	21	1	Resident	461	458
Dunnock	*Prunella modularis*	4	14	13	17	2 (3)	Resident	728	795
Garden Warbler	*Sylvia borin*	4	11	12	14	1 (2)	Migrant	273	140
Goldfinch	***Carduelis carduelis***	**5**	**14**	**15**	**10**	**2 (3)**	**Resident**	**323**	**298**
Greenfinch	***Chloris chloris***	**5**	**14**	**15**	**14**	**2**	**Resident**	**184**	**152**
Linnet	***Linaria cannabina***	**5**	**13**	**13**	**14**	**2 (3)**	**Resident**	**1,035**	**735**
Long-tailed Tit	*Aegithalos caudatus*	7	16	16	14	1	Resident	912	159
Robin	*Erithacus rubecula*	5	14	14	24	2 (3)	Resident	1,318	2,103
Song Thrush	*Turdus philomelos*	4	14	14	21	2–3 (4)	Resident	1,833	951
Whitethroat	***Curruca communis***	**5**	**12**	**13**	**20**	**1–2**	**Migrant**	**262**	**595**
Wren	*Troglodytes troglodytes*	6	16	16	18	2	Resident	777	376
Yellowhammer	***Emberiza citrinella***	**3**	**13**	**14**	**14**	**2 (3)**	**Resident**	**150**	**351**

b) a range of more generalist hedge-nesting species that commonly use farmland habitats (Blackbird *Turdus merula*, Blackcap *Sylvia atricapilla*, Bullfinch *Pyrrhula pyrrhula*, Chaffinch *Fringilla coelebs*, Dunnock *Prunella modularis*, Garden Warbler *Sylvia borin*, Long-tailed Tit *Aegithalos caudatus*, Robin *Erithacus rubecula*, Song Thrush *Turdus philomelos* and Wren *Troglodytes troglodytes*). Of these species, four are typically single-brooded (Chaffinch, Long-tailed Tit, Garden Warbler and Whitethroat) and, aside from replacement clutches, are likely to have more limited breeding windows than the remaining 11, which have the potential to fledge multiple broods per season (Ferguson-Lees et al. 2011, BTO 2023). The full list of species, their conservation status, nesting stage lengths and other relevant ecological information are included in Table 1, alongside available overall sample sizes.

2.3. BTO datasets

The two BTO/JNCC datasets with the potential to provide data on breeding phenology are those generated by the Nest Record Scheme (NRS) and the Ringing Scheme. Participants in the NRS make multiple visits to any nest that they find at self-selected sites, recording the contents and the stage of development using standardised codes and, where possible, documenting the final outcome. Participants in the Ringing Scheme are permitted, if holding the correct endorsement, to fit rings to nestlings and submit ringing records to BTO that use the NRS coding system to indicate the developmental stage; for the purposes of phenological estimation, these ringing records can therefore be treated as single-visit nest records.

The datasets produced by these two demographic schemes are potentially complementary. NRS data generally permit estimation of laying dates with greater accuracy, as participants typically make multiple visits to the nest and provide more detailed data concerning the age of the contents; they also document the phenology of all nests, not just the subset that progress to the nestling stage. Ringing Scheme sample sizes are often higher than the equivalent NRS sample, however, as the latter involves more intensive fieldwork, and the larger volume of data can compensate for the reduced accuracy of the individual records. There is a degree of participant overlap and, for historic data, it is unfortunately challenging to link ringing events to specific nest records and comprehensively remove duplication; the approach taken in this report was therefore to analyse the two datasets separately and compare the accuracy of estimates generated.

2.3.1. Nest Record Scheme (NRS) data

Data from England only, covering the period 2011–21 were used in the analysis, with 2020 excluded due to the impact of the COVID-19 restrictions, which truncated monitoring activities as fieldwork was not permitted in the first half of the season. On the basis of changes in the number of eggs during successive visits to the nest and the developmental stage of any young present – through reference to the published literature concerning length of individual elements of the nesting cycle and chick growth rates – the NRS analytical routines are able to back-calculate a range of potential dates on which the clutch could have been initiated (see Crick et al. 2003 for more detail). The date of clutch initiation, also known as the first egg date (and hereafter termed 'laying date') is taken as the mid-point of that range, with records excluded from analyses if the range exceeds 10 days; the minimum accuracy of estimates is therefore +/- five days.

Estimated fledging dates were extrapolated by adding the following species-specific mean values to the laying date: i) duration of clutch completion, based on average clutch sizes, ii) the incubation period (typically commencing on the penultimate egg for passerines), and iii) the nestling period, as published in BTO Bird Facts (BTO 2023); all mean values for nesting stage duration are presented in Table 1. The date on which young from each nest became independent (hereafter 'independence date'), which marks the end of a nesting attempt, was then calculated by adding an additional estimate of the duration of the post-fledging parental dependency period. This value was derived from the species accounts in *Birds of the Western Palearctic* interactive addition (BirdGuides 2006), supplemented where necessary by information from the online *Birds of the World* (Billerman et al. 2022; https://birdsoftheworld.org/bow/home). Time until independence is typically given as a range and therefore, following the precautionary principal, the maximum value was used in all analyses.

Using a composite dataset containing all 10 years of available data, the 5th, 50th and 95th percentiles of the laying date distribution were calculated, from which it was possible to project the equivalent percentiles for the fledging and independence dates, using the methodology outlined above (see Joys & Crick 2004 for more detail). The degree of overlap between each proposed management period and the distribution of a) active nests (defined as the period between laying of the first egg and fledging), and b) active attempts (defined as the period between laying of the first egg and fledglings reaching independence) was then calculated, using the percentage of monitored nests/attempts as the metric. Species where this overlap exceeds a threshold of i) 5%, and ii) 10% were then highlighted. A few of the focal species, primarily Blackbird and Robin, occasionally breed opportunistically in late winter, particularly in gardens. These data points are unlikely to be relevant to the current study and may skew the distributions presented; any records for which laying date estimates fell before the 1st of February (ordinal date 32) were excluded from the analyses (Blackbird, N=2; Robin, N=1).

2.3.2. Ringing Scheme data

As with NRS, analyses of ringing data were restricted to records originating from England only, collected over the period 2011–19 and 2021. Nesting phenology estimates were derived following the methodology outlined in Wilson et al. (2021). Ringing records are submitted at the level of the individual nestling (pullus); in the absence of a unique brood identifier, issues of pseudo-replication were avoided by identifying groups of ringing records originating from the same four-figure grid reference, and date, retaining only the record relating to the largest (presumed oldest) nestling for analysis. Where the number of ringing records indicated that multiple broods of the same size/age were ringed at a site on the same date, we used ring order and other information associated with the ringing record, such as number of chicks ringed, time of ringing and associated habitat information, to group pulli into broods and applied the same sub-sampling procedure.

The relatively short nestling period for passerines typically restricts pullus ringing to a c.5-day period (Newson et al. 2007). This ensures that chick legs are sufficiently developed for the ring to be retained but they are also not old enough to present a risk of accidental forced-fledging as an innate predator escape behaviour (Streby et al. 2013), a risk that is higher in open cup nesting birds like those examined (Ferguson-Lees et al. 2011). For the species included in this study, the window is expected to occur between five and nine days after hatching (Newson et al. 2007); to standardise between species we therefore assigned all pulli to an age of seven days at ringing, allowing laying dates to be back-calculated and fledging/independence dates to be projected using the same methodology as for the NRS dataset. The only difference was that the back calculation of laying dates for ringing data utilised information about the number of chicks alive at the time of first ringing rather than the mean species clutch size (Wilson et al. 2021).

Where nestlings have been lost post-hatching, this may result in laying date estimates that are slightly later than the true value but, due to the relatively small clutch sizes of the species included here (range = 3–7 eggs, with most species averaging 4–5), the estimated value is not likely to differ by more than one or two days. Using a composite dataset containing all 10 years of available data, the 5th, 50th and 95th percentiles of the laying date, fledging and independence dates were then calculated.

2.3.3. Scheme phenology estimate comparisons

To quantify the influence of survey methodology, laying date estimates for individual species were compared using records taken from non-overlapping sites to avoid the potential for pseudoreplication. Median values of estimated laying dates were compared within each species using boxplots and Mann-Whitney U tests, with P values adjusted to account for multiple comparisons using the Holm method, while density plots and percentile values were used to compare estimated laying date distributions. This comparison was not repeated for the fledging and independence date estimates, as both are derived from laying dates.

This comparison indicated that estimates derived from the NRS dataset were significantly earlier than those derived from the Ringing Scheme for six species and significantly later for two species (Figure A2.1; Table A2.1). Despite differences in the overall distribution of estimates (Figure A2.2), when comparing the equivalent 5th, 50th (median) and 95th laying date percentiles, all estimates fall within 17 days of each other (Table A2.1). The 5th percentile dates were most consistent between the schemes, with estimates for 15 species falling within six days of each other, the exception being Long-tailed Tit, where estimates differered by 16 days. The level of agreement in 50th percentile estimates is similar, with those for 12 species differing by a maximum of seven days and none differing by more than 12 days. The 95th percentile estimates for nine species fall within seven days of each other, and only Greenfinch and Long-tailed Tit differ by more than 14 days (by 15 and 17 days respectively).

Note, due to their nest structure limiting safe access to young, rings are not routinely fitted to Long-tailed Tit pulli and the majority (94%) of the Ringing Scheme data for this species originate from a single academic study undertaken by the University of Sheffield (e.g. Green & Hatchwell 2018); this highly limited geographic distribution, in contrast to the NRS dataset (see Figure A1.1 and Figure A1.2), is likely to account for at least some of the difference identified between estimates for this species. Given that differences are relatively small in magnitude, and that NRS data: i) generally provide more accurate phenological estimates at the level of the individual record, ii) are not restricted to the subset of nests that reach the nestling stage, and iii) exhibit a larger sample size than the Ringing Scheme for 11/15 species, subsequent analyses of annual and spatial variation presented in the main text of this report are limited to analyses of the NRS dataset. Estimates derived from ringing of pulli are provided as appendices.

2.4. Annual variation in phenology

A number of factors could generate annual variation in breeding phenology, including weather conditions and variation in recorder distribution. In addition to presenting composite results for the 10-year period in boxplots, we quantified annual variation in all species (N=8; Blackbird, Blackcap, Dunnock, Linnet, Long-tail Tit, Robin, Song Thrush, Wren) where the NRS sample size exceeded N=50 in at least five of the study years by calculating 95% Confidence Intervals.

2.5. Spatial variation in phenology

Analysis of spatial variation was limited to the NRS dataset. NRS records include metadata relating to latitude, elevation and habitat, all of which have the potential to influence phenology, primarily through impacts on weather conditions and food availability (Morrison et al. 2015, Boyle et al. 2016, Bailey et al. 2022). For the purposes of this report, assessment of the impacts of these factors was restricted to descriptive summaries of the NRS dataset that calculate phenological distributions for subsets of the composite dataset. This approach gives a robust indication of the magnitude of influence of each variable, but interpretation of univariate relationships cannot exclude the possibility that they are driven by confounding effects; formal generation of predicted values using a multivariate modelling approach would address any uncertainty but was beyond the scope of this project. We used thresholds of seven and 14 days to identify differences that might be of significant magnitude to inform management decisions.

2.5.1. Latitudinal analysis

Each record in the NRS dataset is associated with a spatial reference, typically a grid reference, the minimum resolution generally being the 1-km square. Birds breeding further north are predicted to initiate breeding later than their conspecifics nesting further south (Morrison et al. 2015, Phillimore et al. 2016). To account for any differences in nesting phenology linked to latitude, the data were summarised using two approaches. Firstly, the NRS dataset was divided into northern and southern England using 53°N which approximately equates to the mid-point on the longest continuous North–South axis within mainland England, as the cut-off between the two categories. To provide greater detail, the records were then split into five broad latitudinal bands (<51.5°, 51.5–52.49°, 52.5–53.49°, 53.5–54.49°, >54.5°). Due to the uneven distribution of records and low samples sizes for some species in some specific latitude bands (Figure A1.1, Figure A1.2), only those species exceeding a threshold of greater than 50 records submitted in both the North and South (N=13; Blackbird, Blackcap, Bullfinch, Chaffinch, Dunnock, Garden Warbler, Goldfinch, Linnet, Long-tailed Tit, Robin, Song Thrush, Whitethroat, Wren) or in at least three of the five latitudinal bands (N=10; Blackbird, Blackcap, Chaffinch, Dunnock, Goldfinch, Linnet, Long-tailed Tit, Robin, Song Thrush, and Wren) were included in this breakdown.

2.5.2. Elevation analysis

Birds at higher elevations are predicted to initiate breeding later than their conspecifics at lower levels (Boyle et al. 2016, Bründl et al. 2020). Mean elevation (metres above sea level) per 1 km Ordnance Survey grid reference was derived from the GGIAR-SRTM 90 m raster (Jarvis et al. 2008, available at http://srtm.csi.cgiar.org) to provide a representative and comparable elevation estimate for each NRS record. As >84% of records in all species originated from below 200 m elevation – and >49% from below 100 m elevation – in all species, the power to consider effects was limited (Figure A1.3). We therefore divided the records into two categories, <200 m and ≥200 m (Figure A1.3) and reported only those species with at least 50 records in both elevation bands (N=6; Blackbird, Chaffinch, Linnet, Long-tailed Tit, Robin, and Song Thrush).

2.5.3. Habitat analysis
All NRS records are associated with a Crick habitat code (Crick 1992) selected by the volunteer, which typically represents the type of vegetation present in the immediate proximity of the nest. The primary habitat types relating to records used in this study were farmland and scrubland, and only species for which at least 50 records were available from each of these habitats were included in this element of the analysis (N=10; Blackbird, Blackcap, Chaffinch, Dunnock, Linnet, Long-tailed Tit, Robin, Song Thrush, Whitethroat, and Wren). For these species, estimates of phenology were calculated for individual habitats, with those generated from samples collected at human sites and woodland sites also presented to provide additional context. To investigate the effects of habitat on phenology at a landscape scale, percentage land cover for the 1 km Ordnance Survey square was extracted from the UK 2015 Land Cover Map (LCM) from the UK Centre for Ecology and Hydrology (Rowland et al. 2017) on the basis of the grid reference provided by the survey participant. Squares were then categorised by the single most common land cover type present in each, and phenology estimates calculated individually for each of the dominant habitat types. 'Arable' and 'Improved grassland' were the best-represented habitats and most relevant to this study, with each accounting for c.30% of data with again only species with at least 50 records from both landscape types included for analysis (N=12; Blackbird, Blackcap, Chaffinch, Dunnock, Garden Warbler. Goldfinch, Linnet, Long-tailed Tit, Robin, Song Thrush, Whitethroat, and Wren).

3. Results for Nest Record Scheme phenological analysis

3.1. Overall phenology of nesting for farmland hedgerow-breeding birds
Species-specific estimates of laying, fledging and independence date percentiles generated from NRS data are presented in Table 2, alongside the respective sample sizes, and the full distributions of these variables are plotted in Figures 1 and 2. Table 3 indicates the proportion, relative to the annual total, of: i) active nests and ii) active breeding attempts (see Section 2.3.1 for respective definitions) of each species that overlap with the management period proposed for each of the current and potential hedgerow management scenarios. Figure 2 provides a graphical representation of the overlap between active breeding attempts and management periods.

Breeding activity after 31st July
Nests of 14/15 species still contained eggs or nestlings after 31st July (Blackbird, Blackcap, Bullfinch, Chaffinch, Dunnock, Garden Warbler, Goldfinch, Greenfinch, Linnet, Robin, Song Thrush, Whitethroat, Wren, and Yellowhammer), and for two of these species, at least 10% of nests were still active in the first half of August (Yellowhammer 26% and Bullfinch, 10%), while two more came close to this threshold (Goldfinch 9.9% and Linnet 9.5%). Where dependent young were also considered, attempts of 14/15 species were still active after 31st July, the exception being Long-tailed Tit, and for six species this accounted for more than 10% of the annual attempt total (Yellowhammer 38%, Bullfinch 26%, Linnet 16%, Goldfinch 16%, Whitethroat 13%, and Wren 11%).

Breeding activity after 14th August
Nests were still active for 11/15 species after 14th August (Blackbird, Blackcap, Bullfinch, Dunnock, Goldfinch, Greenfinch, Linnet, Robin, Song Thrush, Wren, and Yellowhammer), with Yellowhammer being the only one of these species where the overlap exceeded 10% of attempts (12%). Where dependent fledglings were also considered, attempts of 14/15 species remained active in the second half of August (Blackbird, Blackcap, Bullfinch, Chaffinch, Dunnock, Garden Warbler, Goldfinch, Greenfinch, Linnet, Robin, Song Thrush, Whitethroat, Wren, and Yellowhammer), of which three species exhibited an overlap of greater than 10% of attempts (Yellowhammer 28%, Bullfinch 15%, and Linnet 10%).

Breeding activity after 31st August
Active nests were still present for 6/15 species after 31st August (Bullfinch, Goldfinch, Linnet, Song Thrush, Wren, and Yellowhammer) but the maximum proportion of annual breeding attempts this related to did not exceed 1.5% for any species. Where dependent fledglings were also considered, attempts of 12/15 species remained active (Blackbird, Blackcap, Bullfinch, Chaffinch, Dunnock, Goldfinch, Greenfinch, Linnet, Robin, Song Thrush, Wren, and Yellowhammer) but the degree of overlap did not exceed 10% of attempts for any species; Yellowhammer exhibited the greatest degree of overlap (9%).

Table 2. The 5th, 50th, 95th and 100th percentiles for laying, fledging and post-fledging independence dates for all focal species between 2011–21 (excluding 2020) derived from the BTO Nest Record Scheme across all habitats. To indicate overlap with current/potential management periods dates that fall withing the early August period (1st–14th) are highlighted in yellow, within the late August period (15th–31st) in orange, within the early September period (1st–14th) in red and on/after the 15th September period in purple. See Table A3.1 for the equivalent estimates from the pullus ringing data.

	First egg laying date percentiles				Fledging date percentiles				Post-fledging independence date percentiles				Number of records
Species	5th	50th	95th	100th	5th	50th	95th	100th	5th	50th	95th	100th	
Blackbird	18-Mar	17-Apr	15-Jun	08-Aug	19-Apr	19-May	17-Jul	09-Sep	14-May	13-Jun	11-Aug	04-Oct	4,029
Blackcap	18-Apr	05-May	15-Jun	19-Jul	17-May	03-Jun	14-Jul	17-Aug	07-Jun	24-Jun	04-Aug	07-Sep	824
Bullfinch	21-Apr	22-May	07-Jul	05-Aug	26-May	26-Jun	11-Aug	09-Sep	15-Jun	16-Jul	31-Aug	29-Sep	199
Chaffinch	07-Apr	30-Apr	04-Jun	12-Jul	07-May	30-May	04-Jul	11-Aug	28-May	20-Jun	25-Jul	01-Sep	461
Dunnock	28-Mar	23-Apr	20-Jun	30-Jul	28-Apr	24-May	21-Jul	30-Aug	15-May	10-Jun	07-Aug	16-Sep	728
Garden Warbler	29-Apr	15-May	19-Jun	11-Jul	26-May	11-Jun	16-Jul	07-Aug	09-Jun	25-Jun	30-Jul	21-Aug	273
Goldfinch	11-Apr	12-May	12-Jul	06-Aug	15-May	15-Jun	15-Aug	09-Sep	25-May	25-Jun	25-Aug	19-Sep	323
Greenfinch	27-Mar	02-May	22-Jun	23-Jul	30-Apr	05-Jun	26-Jul	26-Aug	14-May	19-Jun	09-Aug	09-Sep	184
Linnet	17-Apr	11-May	13-Jul	09-Aug	18-May	11-Jun	13-Aug	09-Sep	01-Jun	25-Jun	27-Aug	23-Sep	1,035
Long-tailed Tit	21-Mar	03-Apr	24-Apr	23-May	29-Apr	12-May	02-Jun	01-Jul	13-May	26-May	16-Jun	15-Jul	912
Robin	13-Mar	12-Apr	31-May	16-Jul	15-Apr	15-May	03-Jul	18-Aug	09-May	08-Jun	27-Jul	11-Sep	1,318
Song Thrush	21-Mar	15-Apr	16-Jun	03-Aug	22-Apr	17-May	18-Jul	04-Sep	13-May	07-Jun	08-Aug	25-Sep	1,833
Whitethroat	28-Apr	16-May	30-Jun	12-Jul	28-May	15-Jun	30-Jul	11-Aug	17-Jun	05-Jul	19-Aug	31-Aug	262
Wren	13-Apr	04-May	17-Jun	04-Aug	21-May	11-Jun	25-Jul	11-Sep	08-Jun	29-Jun	12-Aug	29-Sep	777
Yellowhammer	30-Apr	07-Jun	23-Jul	08-Aug	30-May	07-Jul	22-Aug	07-Sep	13-Jun	21-Jul	05-Sep	21-Sep	150

Figure 1. Histogram and density plots of laying, fledging and post-fledging independence dates for all focal species between 2011–21 (excluding 2020), derived from the BTO/JNNC Nest Record Scheme dataset, binned into five-day periods. The coloured vertical dashed lines indicate the 95th percentiles for the respective nest stages; N = sample size. See Figure A3.1 for the equivalent estimates from the pullus ringing data.

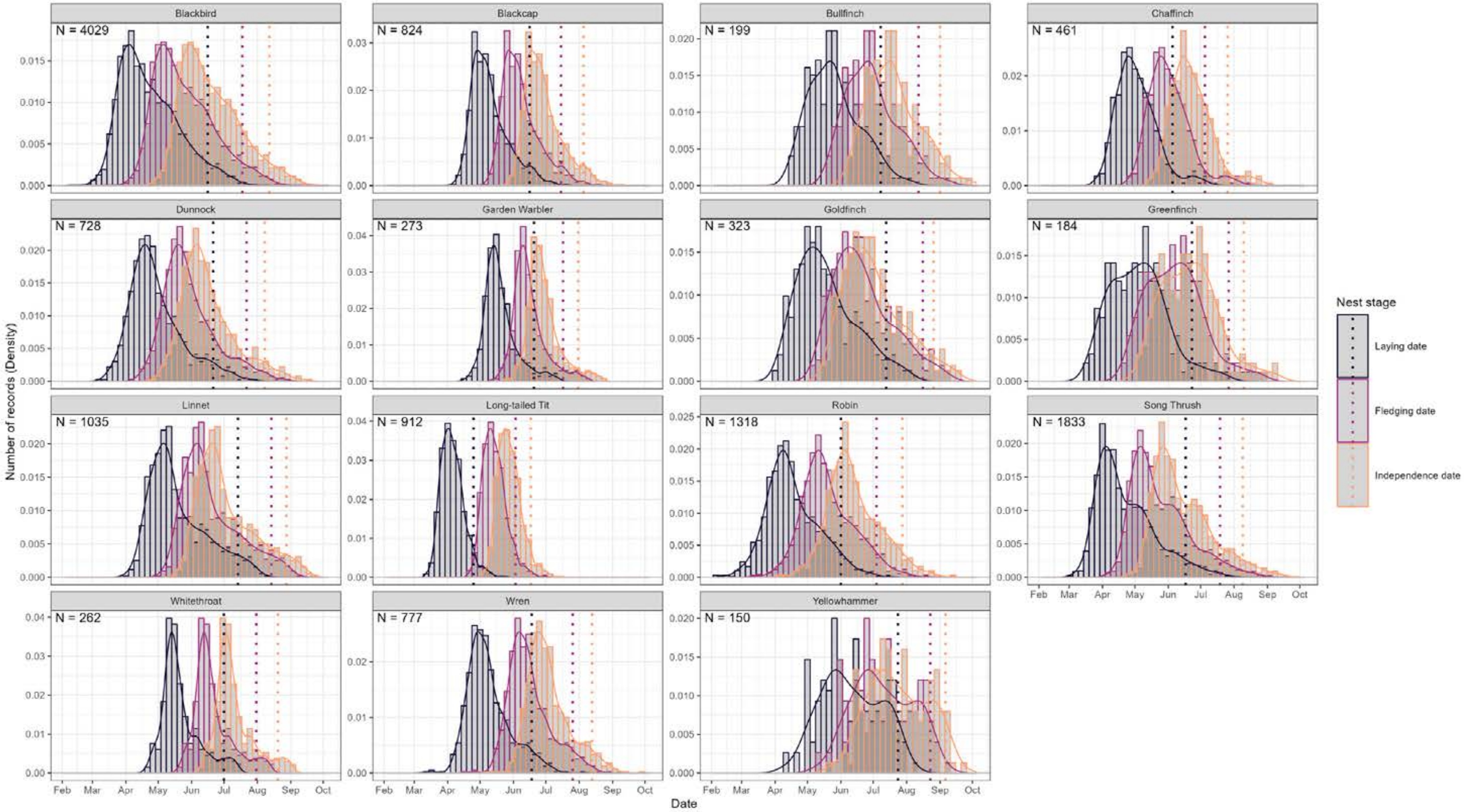
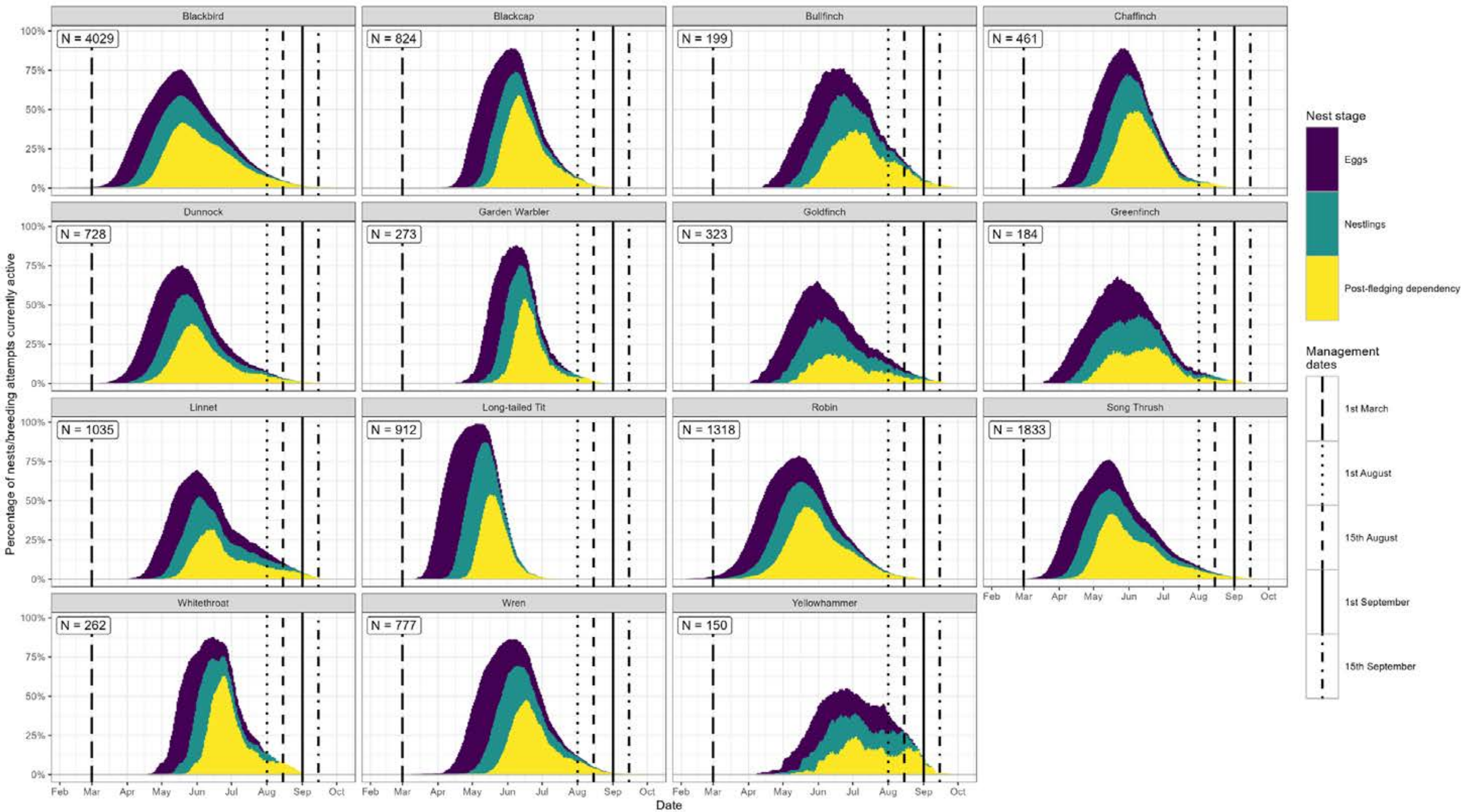


Table 3. The overall percentage of breeding attempts monitored by the BTO/JNCC Nest Record Scheme that i) relate to active nests (i.e. those containing live eggs and/or chicks), or ii) relate to active breeding attempts, (i.e. all active nests plus those attempts where young have fledged but are yet to reach independence), at the start of each of the current/potential hedgerow management scenario cut-off dates. Periods with more 5% of attempts remaining active are highlighted in orange, those with more than 10% in red and those with more than 20% in purple. See Table A4.1 for the equivalent estimates from the pullus ringing data.

	i) Percentage of nests still active				ii) Percentage of breeding attempts still active			
Species	1st Aug onwards	15th Aug onwards	1st Sep onwards	15th Sep onwards	1st Aug onwards	15th Aug onwards	1st Sep onwards	15th Sep onwards
Blackbird	1.6%	0.3%	0.0%	0.0%	8.4%	4.1%	1.1%	0.2%
Blackcap	0.7%	0.1%	0.0%	0.0%	6.4%	1.3%	0.1%	0.0%
Bullfinch	10.1%	4.0%	1.0%	1.0%	26.6%	16.1%	4.5%	1.5%
Chaffinch	0.9%	0.0%	0.0%	0.0%	3.9%	1.7%	0.2%	0.0%
Dunnock	2.5%	0.5%	0.0%	0.0%	6.6%	2.7%	0.5%	0.1%
Garden Warbler	1.1%	0.0%	0.0%	0.0%	4.8%	1.1%	0.0%	0.0%
Goldfinch	9.9%	4.6%	1.2%	1.2%	16.4%	8.0%	4.0%	0.6%
Greenfinch	3.8%	1.6%	0.0%	0.0%	7.1%	3.8%	1.6%	0.0%
Linnet	9.5%	4.2%	0.2%	0.2%	16.5%	10.0%	3.8%	0.4%
Long-tailed Tit	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Robin	0.4%	0.2%	0.0%	0.0%	4.0%	1.3%	0.2%	0.0%
Song Thrush	2.1%	0.8%	0.1%	0.1%	7.2%	3.5%	1.1%	0.2%
Whitethroat	4.6%	0.0%	0.0%	0.0%	13.0%	7.3%	0.0%	0.0%
Wren	2.8%	0.4%	0.1%	0.1%	11.3%	4.4%	0.5%	0.1%
Yellowhammer	26.0%	12.0%	0.7%	0.7%	38.0%	26.7%	9.3%	0.7%

Figure 2. Stacked histograms showing the percentage of all monitored nests that were active on any given day during the breeding season by nest stage for all focal species between 2011–21 (excluding 2020), as derived from the BTO/JNCC Nest Record Scheme dataset across all habitats. The vertical lines highlight key dates of current/potential hedgerow management scenarios with the lines for 1st August–15th September corresponding to percentages of nests remaining active reported in Table 3ii. N=sample size. See Figure A4.1 for the equivalent estimates from the pullus ringing data.



Breeding activity after 14th September
Active nests were not detected for any species after 14th September but, when dependent fledglings were considered, attempts of 8/15 species could be classed as active after this date (Blackbird, Bullfinch, Dunnock, Goldfinch, Linnet, Song Thrush, Wren, and Yellowhammer). For the majority of species, these attempts comprised < 1% of the annual total, the exception being Bullfinch (1.5%).

3.2. Annual variation in nesting phenology variation
A small amount of variation in annual nesting phenology, as measured by clutch initiation date, was apparent for the eight species for which sufficient data were available (Table 4; Figure 3). The 95% Confidence Intervals around estimates of the 95th percentile of the laying date distribution fell within 6–7 days for all species considered, however, indicating that the timing of the end of the breeding season generally varied by no more than a week from year to year.

3.3. Variation in nesting phenology with latitude
Estimates of breeding phenology generated for southern and northern England were generally similar (Table 5; Figure 4), with the 95th percentile of the laying date distribution differing by no more than a week for the 12/13 species possessing sufficiently large samples sizes in both northern and southern England to permit comparison (Blackbird, Blackcap, Bullfinch, Chaffinch, Dunnock, Garden Warbler, Linnet, Long-tailed Tit, Robin, Song Thrush, and Wren). The largest difference was exhibited by Whitethroat (nine days). In terms of directionality, the 95th percentile fell earlier in the south for 6/13 species (Blackbird, Chaffinch, Long-tailed Tit, Robin, Song Thrush, and Wren), later for 5/13 species (Bullfinch, Dunnock, Goldfinch, Linnet, and Whitethroat) and the remaining two species demonstrated no difference (Blackcap and Garden Warbler).

The analysis was repeated at finer scale, dividing England into five latitude bands, for the subset of species where >50 NRS records were available for at least three of these bands (Table 6; Figure 5; Appendix 6) and again, some variation was apparent. The fact that no consistent spatial trend with latitude was apparent, and that the magnitude of the variation detected for some species was greater than that identified in the coarser scale analysis above, suggests that sample sizes were insufficient to allow generation of robust estimates.

3.4. Variation in nesting phenology with elevation
Estimates of breeding phenology generated for two elevation bands, one including nests located up to 200 m above sea level and the other including nests at 200 m or higher, were similar (Table 7; Figure 7; Appendix 7). For the six species where at least 50 records were collected at 200 m or higher elevation (N=6) the 95th percentile of the laying date distribution varied by a maximum of 10 days (Long-tailed Tit and Song Thrush), and by a week or less for the majority (Blackbird, Chaffinch, Linnet and Robin). Visual examination suggested that the direction of this difference was not consistent, however, with clutch initiation ceasing earlier at lower elevations for two species (Blackbird, Long-tailed Tit) and at higher elevations for three species (Chaffinch, Linnet, and Song Thrush).

3.5. Variation in nesting phenology with habitat
3.5.1. Local-scale habitat
Sufficient data were available to generate farmland- and scrubland-specific distributions of breeding phenology for 10/15 species (Blackbird, Blackcap, Chaffinch, Dunnock, Linnet, Long-tailed Tit, Robin, Song Thrush, Whitethroat, and Wren; Table 8; Figure 8; Appendix 8), where habitat was classified on the basis of Crick habitat codes allocated by volunteers. The 95th percentile of the laying date distribution varied by between one day (Blackcap) and 29 days (Chaffinch), averaging 12 days. Visual inspection of estimates suggested that the clutch initiation period appeared to end earlier in scrubland than in farmland for eight species; for completeness, estimates for human sites and woodland are also provided in Table 8, Figure 8 and Appendix 8.

3.5.2. Landscape-scale habitat
For the 12 species for which at least 50 records were submitted from both arable-dominated and improved-grassland-dominated landscapes (Blackbird, Blackcap, Chaffinch, Dunnock, Garden Warbler, Goldfinch, Linnet, Long-tailed Tit, Robin, Song Thrush, Whitethroat, and Wren), the estimate of the 95th percentile of the laying date distribution differed by between one and 24 days, averaging 14 days (Table 9; Figure 9; Appendix 8). With the exception of Long-tailed Tit, results indicated that species ceased laying later in arable-dominated landscapes, on average by 15 days.

Table 4. The mean and 95% confidence intervals (in days) of the 5th, median (50th) and 95th percentile annual laying dates for those focal species for which at least 50 Nest Record Scheme records were submitted in at least five years.

Species	Annual 5th percentile	variation	Annual 95th percentile	variation	Annual 95th percentile	variation	Years >50 samples
Blackbird	17-Apr	± 6.8	13-May	± 6.8	11-Jul	± 6.8	10
Blackcap	16-May	± 5.9	30-May	± 6.0	08-Jul	± 6.1	10
Dunnock	22-Apr	± 5.7	17-May	± 5.6	11-Jul	± 5.8	9
Linnet	14-May	± 5.5	03-Jun	± 5.4	01-Aug	± 5.9	10
Long-tailed Tit	22-Apr	± 6.4	03-May	± 6.5	22-May	± 6.4	10
Robin	12-Apr	± 6.8	10-May	± 6.7	26-Jun	± 6.9	10
Song Thrush	19-Apr	± 6.4	12-May	± 6.4	10-Jul	± 6.8	10
Wren	15-May	± 6.8	02-Jun	± 6.7	16-Jul	± 6.6	8

Figure 3. Boxplots showing the annual distribution of laying date estimates from breeding attempts monitored by the BTO/JNCC Nest Record Scheme. "Whiskers" indicate the 5th and 95th percentile estimates; points relate to individual estimates that fall outside either the 1st or 99th percentiles. The horizontal red line shows the overall median (50th percentile) laying dates. The numbers below each boxplot indicate the annual sample size.

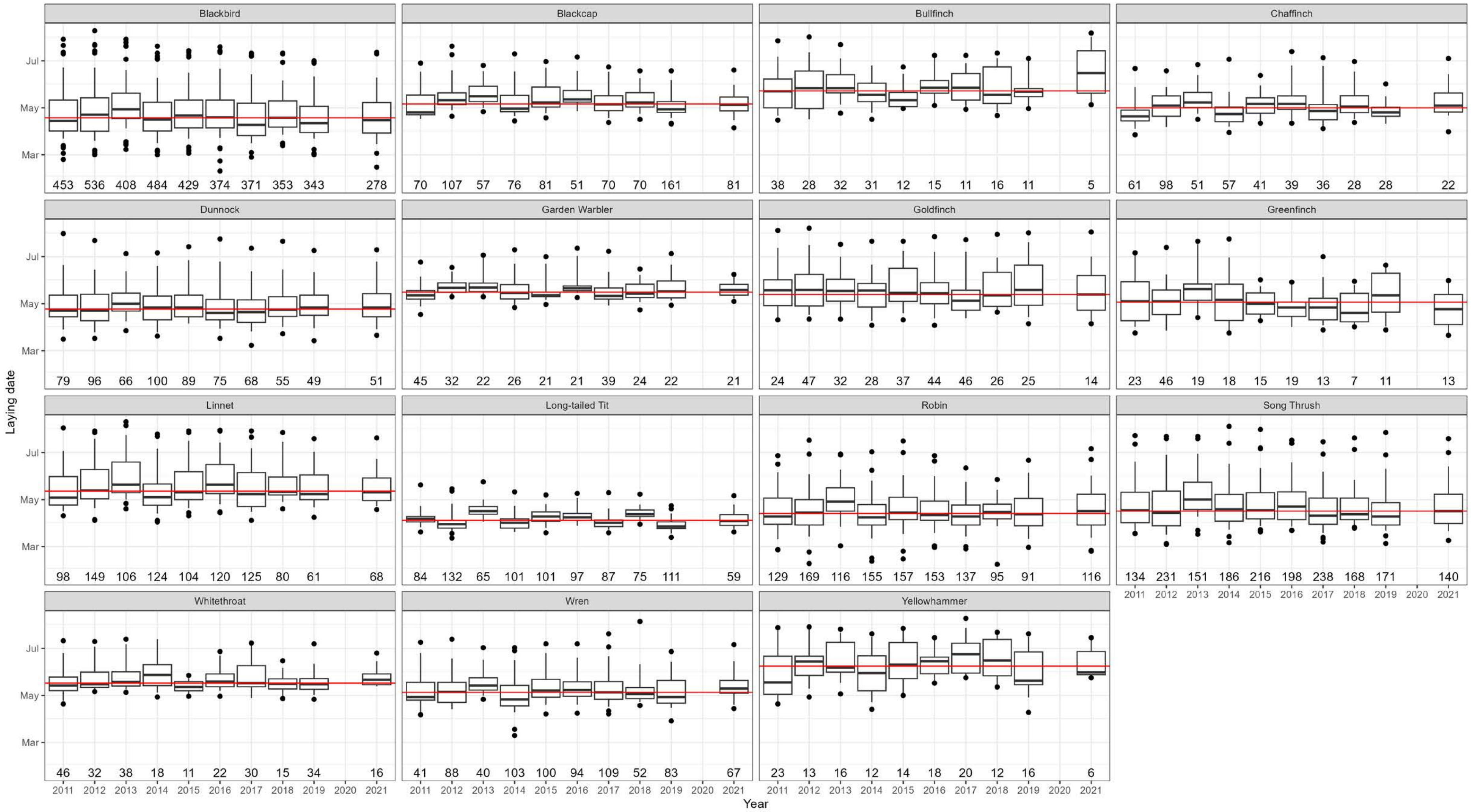


Table 5. 5th, 50th and 95th percentiles of the distribution of laying, fledging and independence dates in northern and southern England, using 53°N as a dividing line, between 2011–21 (excluding 2020) derived from the BTO/JNCC Nest Record Scheme dataset, for species with more than 50 records in both regions. To indicate overlap with current/potential management scenarios, dates extending into early August (1st–14th) are highlighted in yellow and those extending into late August (15th–31st) are highlighted in orange.

Species	Region	First egg laying date percentiles			Fledging date percentiles			Post-fledging independence date percentiles			Number of records
		5th	50th	95th	5th	50th	95th	5th	50th	95th	
Blackbird	North	23-Mar	27-Apr	21-Jun	24-Apr	29-May	23-Jul	19-May	23-Jun	17-Aug	1,260
	South	17-Mar	14-Apr	12-Jun	18-Apr	16-May	14-Jul	13-May	10-Jun	08-Aug	2,769
Blackcap	North	23-Apr	08-May	15-Jun	22-May	06-Jun	14-Jul	12-Jun	27-Jun	04-Aug	185
	South	17-Apr	05-May	15-Jun	16-May	03-Jun	14-Jul	06-Jun	24-Jun	04-Aug	639
Bullfinch	North	22-Apr	23-May	03-Jul	28-May	27-Jun	06-Aug	17-Jun	17-Jul	26-Aug	71
	South	20-Apr	22-May	07-Jul	25-May	26-Jun	11-Aug	14-Jun	16-Jul	31-Aug	128
Chaffinch	North	10-Apr	30-Apr	08-Jun	10-May	30-May	08-Jul	31-May	20-Jun	29-Jul	183
	South	06-Apr	29-Apr	01-Jun	06-May	29-May	01-Jul	27-May	19-Jun	22-Jul	278
Dunnock	North	01-Apr	22-Apr	15-Jun	02-May	23-May	15-Jul	19-May	09-Jun	02-Aug	191
	South	26-Mar	24-Apr	21-Jun	26-Apr	25-May	22-Jul	13-May	11-Jun	08-Aug	537
Garden Warbler	North	27-Apr	18-May	18-Jun	24-May	14-Jun	15-Jul	07-Jun	28-Jun	29-Jul	84
	South	01-May	14-May	18-Jun	28-May	10-Jun	15-Jul	11-Jun	24-Jun	29-Jul	189
Goldfinch	North	10-Apr	07-May	01-Jul	14-May	10-Jun	04-Aug	24-May	20-Jun	14-Aug	99
	South	12-Apr	16-May	13-Jul	16-May	19-Jun	16-Aug	26-May	29-Jun	26-Aug	224
Linnet	North	16-Apr	11-May	05-Jul	17-May	11-Jun	05-Aug	31-May	25-Jun	19-Aug	185
	South	17-Apr	11-May	15-Jul	18-May	11-Jun	15-Aug	01-Jun	25-Jun	29-Aug	850
Long-tailed Tit	North	24-Mar	05-Apr	30-Apr	02-May	14-May	08-Jun	16-May	28-May	22-Jun	285
	South	20-Mar	02-Apr	22-Apr	28-Apr	11-May	31-May	12-May	25-May	14-Jun	627
Robin	North	13-Mar	14-Apr	08-Jun	16-Apr	17-May	11-Jul	10-May	10-Jun	04-Aug	411
	South	13-Mar	11-Apr	29-May	15-Apr	14-May	01-Jul	09-May	07-Jun	25-Jul	907
Song Thrush	North	25-Mar	22-Apr	20-Jun	26-Apr	24-May	22-Jul	17-May	14-Jun	12-Aug	478
	South	20-Mar	13-Apr	14-Jun	21-Apr	15-May	16-Jul	12-May	05-Jun	06-Aug	1,355
Whitethroat	North	06-May	18-May	29-Jun	05-Jun	17-Jun	29-Jul	25-Jun	07-Jul	18-Aug	58
	South	27-Apr	15-May	01-Jul	27-May	14-Jun	31-Jul	16-Jun	04-Jul	20-Aug	204
Wren	North	12-Apr	05-May	21-Jun	20-May	12-Jun	29-Jul	07-Jun	30-Jun	16-Aug	231
	South	13-Apr	04-May	15-Jun	21-May	11-Jun	23-Jul	08-Jun	29-Jun	10-Aug	546

Table 6. 5th, 50th and 95th percentiles of the distributions of laying, fledging and independence dates by latitude band in England, derived from the BTO/JNCC Nest Record Scheme dataset for those species where at least 50 records were available for at least three out of five bands between 2011–21 (excluding 2020). Latitude bands with fewer the 50 records are written in grey. To indicate overlap with current/potential management scenarios, dates extending into early August (1st–14th) are highlighted in yellow, those extending into late August (15th–31st) are highlighted in orange, and those extending into early September (1st–14th) are highlighted in red.

Species	Latitudinal band	First egg laying date percentiles			Fledging date percentiles			Post-fledging date percentiles			Number of records
		5th	50th	95th	5th	50th	95th	5th	50th	95th	
Blackbird	<51.5°	16-Mar	13-Apr	06-Jun	17-Apr	15-May	08-Jul	12-May	09-Jun	02-Aug	1,081
	51.5–52.49°	18-Mar	13-Apr	17-Jun	19-Apr	15-May	19-Jul	14-May	09-Jun	13-Aug	1,351
	52.5–53.49°	21-Mar	23-Apr	18-Jun	22-Apr	25-May	20-Jul	17-May	19-Jun	14-Aug	858
	53.5–54.49°	24-Mar	29-Apr	21-Jun	25-Apr	31-May	23-Jul	20-May	25-Jun	17-Aug	546
	>54.5°	25-Mar	23-Apr	12-Jun	26-Apr	25-May	14-Jul	21-May	19-Jun	08-Aug	193
Blackcap	<51.5°	15-Apr	30-Apr	30-May	14-May	30-May	28-Jun	04-Jun	19-Jun	19-Jul	268
	51.5–52.49°	18-Apr	08-May	19-Jun	17-May	06-Jun	18-Jul	07-Jun	27-Jun	08-Aug	343
	52.5–53.49°	23-Apr	05-May	14-Jun	22-May	03-Jun	13-Jul	12-Jun	24-Jun	03-Aug	84
	53.5–54.49°	24-Apr	08-May	02-Jun	23-May	06-Jun	01-Jul	13-Jun	27-Jun	22-Jul	43
	>54.5°	23-Apr	12-May	13-Jun	22-May	09-Jun	13-Jul	12-Jun	01-Jul	02-Aug	86
Chaffinch	<51.5°	06-Apr	26-Apr	04-Jun	06-May	26-May	04-Jul	27-May	16-Jun	25-Jul	108
	51.5–52.49°	05-Apr	30-Apr	26-May	05-May	30-May	25-Jun	26-May	19-Jun	16-Jul	148
	52.5–53.49°	08-Apr	02-May	08-Jun	08-May	01-Jun	08-Jul	29-May	22-Jun	29-Jul	91
	53.5–54.49°	11-Apr	30-Apr	09-Jun	11-May	30-May	09-Jul	01-Jun	20-Jun	30-Jul	75
	>54.5°	13-Apr	29-Apr	24-May	13-May	29-May	23-Jun	03-Jun	19-Jun	14-Jul	39
Dunnock	<51.5°	24-Mar	21-Apr	03-Jun	24-Apr	22-May	04-Jul	11-May	08-Jun	21-Jul	213
	51.5–52.49°	29-Mar	26-Apr	25-Jun	29-Apr	27-May	26-Jul	16-May	13-Jun	12-Aug	279
	52.5–53.49°	30-Mar	19-Apr	18-Jun	30-Apr	20-May	19-Jul	17-May	06-Jun	05-Aug	120
	53.5–54.49°	02-Apr	21-Apr	15-Jun	03-May	22-May	16-Jul	20-May	08-Jun	02-Aug	56
	>54.5°	08-Apr	26-Apr	13-Jun	09-May	27-May	14-Jul	26-May	13-Jun	31-Jul	60
Goldfinch	<51.5°	11-Apr	16-May	13-Jul	15-May	19-Jun	16-Aug	25-May	29-Jun	26-Aug	86
	51.5–52.49°	18-Apr	17-May	13-Jul	22-May	20-Jun	16-Aug	01-Jun	30-Jun	26-Aug	95
	52.5–53.49°	09-Apr	08-May	30-Jun	13-May	11-Jun	03-Aug	23-May	21-Jun	13-Aug	89
	53.5–54.49°	09-Apr	02-May	10-Jul	13-May	05-Jun	13-Aug	23-May	15-Jun	23-Aug	38
	>54.5°	18-Apr	12-May	11-Jul	22-May	15-Jun	14-Aug	01-Jun	25-Jun	24-Aug	15

Linnet	<51.5°	18-Apr	09-May	08-Jul	19-May	09-Jun	08-Aug	02-Jun	23-Jun	22-Aug	313
	51.5–52.49°	16-Apr	10-May	22-Jul	17-May	10-Jun	22-Aug	31-May	24-Jun	05-Sep	362
	52.5–53.49°	16-Apr	11-May	05-Jul	17-May	11-Jun	05-Aug	31-May	25-Jun	19-Aug	236
	53.5–54.49°	24-Apr	29-May	08-Jul	25-May	29-Jun	08-Aug	08-Jun	13-Jul	22-Aug	67
	>54.5°	18-Apr	07-May	09-Jun	19-May	07-Jun	10-Jul	02-Jun	21-Jun	24-Jul	57
Long-tailed Tit	<51.5°	19-Mar	01-Apr	21-Apr	27-Apr	10-May	30-May	11-May	24-May	13-Jun	269
	51.5–52.49°	21-Mar	03-Apr	23-Apr	29-Apr	12-May	01-Jun	13-May	26-May	15-Jun	236
	52.5–53.49°	22-Mar	03-Apr	25-Apr	30-Apr	12-May	03-Jun	14-May	26-May	17-Jun	229
	53.5–54.49°	26-Mar	10-Apr	02-May	04-May	18-May	10-Jun	18-May	01-Jun	24-Jun	88
	>54.5°	25-Mar	07-Apr	28-Apr	03-May	16-May	06-Jun	17-May	30-May	20-Jun	90
Robin	<51.5°	12-Mar	10-Apr	27-May	14-Apr	13-May	29-Jun	08-May	06-Jun	23-Jul	382
	51.5–52.49°	13-Mar	11-Apr	30-May	15-Apr	14-May	02-Jul	09-May	07-Jun	26-Jul	421
	52.5–53.49°	10-Mar	12-Apr	07-Jun	12-Apr	15-May	10-Jul	06-May	08-Jun	03-Aug	279
	53.5–54.49°	12-Mar	14-Apr	06-Jun	14-Apr	18-May	09-Jul	08-May	11-Jun	02-Aug	136
	>54.5°	29-Mar	16-Apr	29-May	01-May	19-May	01-Jul	25-May	12-Jun	25-Jul	100
Song Thrush	<51.5°	18-Mar	10-Apr	07-Jun	19-Apr	12-May	09-Jul	10-May	02-Jun	30-Jul	599
	51.5–52.49°	22-Mar	17-Apr	21-Jun	23-Apr	19-May	23-Jul	14-May	09-Jun	13-Aug	663
	52.5–53.49°	21-Mar	16-Apr	16-Jun	22-Apr	18-May	18-Jul	13-May	09-Jun	08-Aug	224
	53.5–54.49°	29-Mar	27-Apr	24-Jun	30-Apr	29-May	26-Jul	21-May	19-Jun	16-Aug	186
	>54.5°	26-Mar	17-Apr	08-Jun	27-Apr	19-May	10-Jul	18-May	09-Jun	31-Jul	161
Wren	<51.5°	14-Apr	04-May	15-Jun	22-May	11-Jun	23-Jul	09-Jun	29-Jun	10-Aug	260
	51.5–52.49°	11-Apr	05-May	16-Jun	19-May	12-Jun	24-Jul	06-Jun	30-Jun	11-Aug	207
	52.5–53.49°	15-Apr	05-May	19-Jun	23-May	12-Jun	27-Jul	10-Jun	30-Jun	14-Aug	208
	53.5–54.49°	09-Apr	29-Apr	16-Jun	17-May	06-Jun	24-Jul	04-Jun	24-Jun	11-Aug	71
	>54.5°	20-Apr	03-May	21-Jun	28-May	10-Jun	29-Jul	15-Jun	28-Jun	16-Aug	31

Figure 4. Density plot of laying dates in northern and southern England, using 53°N as a dividing line, for all species for which at least 50 BTO/JNCC Nest Record Scheme records in both regions over the study period. N=sample size. For the equivalent fledging and independence density plots see Appendix 5.

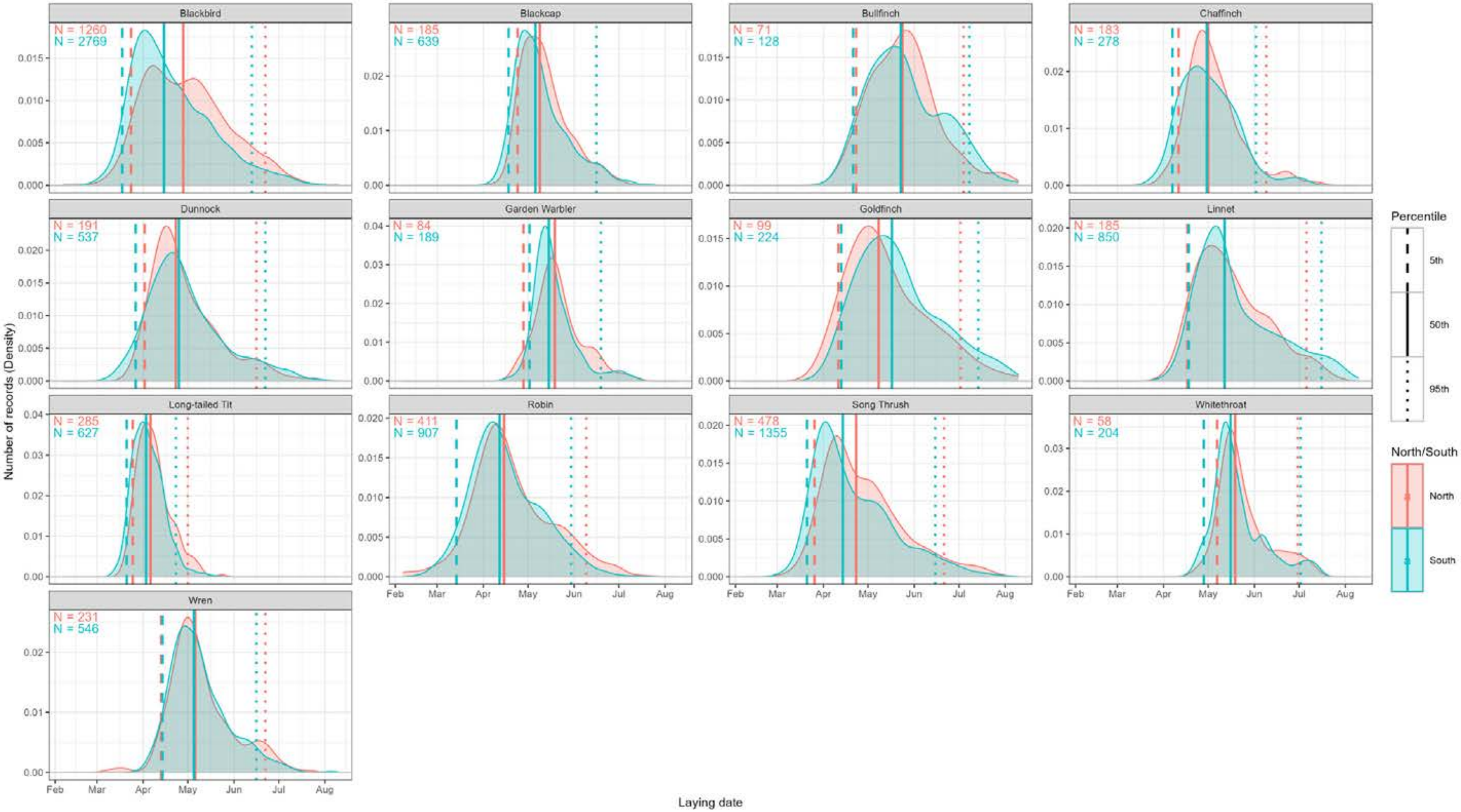


Figure 5. Density plot of laying dates by latitude band in England for all species for which at least 50 BTO/JNCC Nest Record Scheme records have been submitted from at least three of the five latitude bands over the study period. For the equivalent fledging and independence date density plots see Appendix 6.

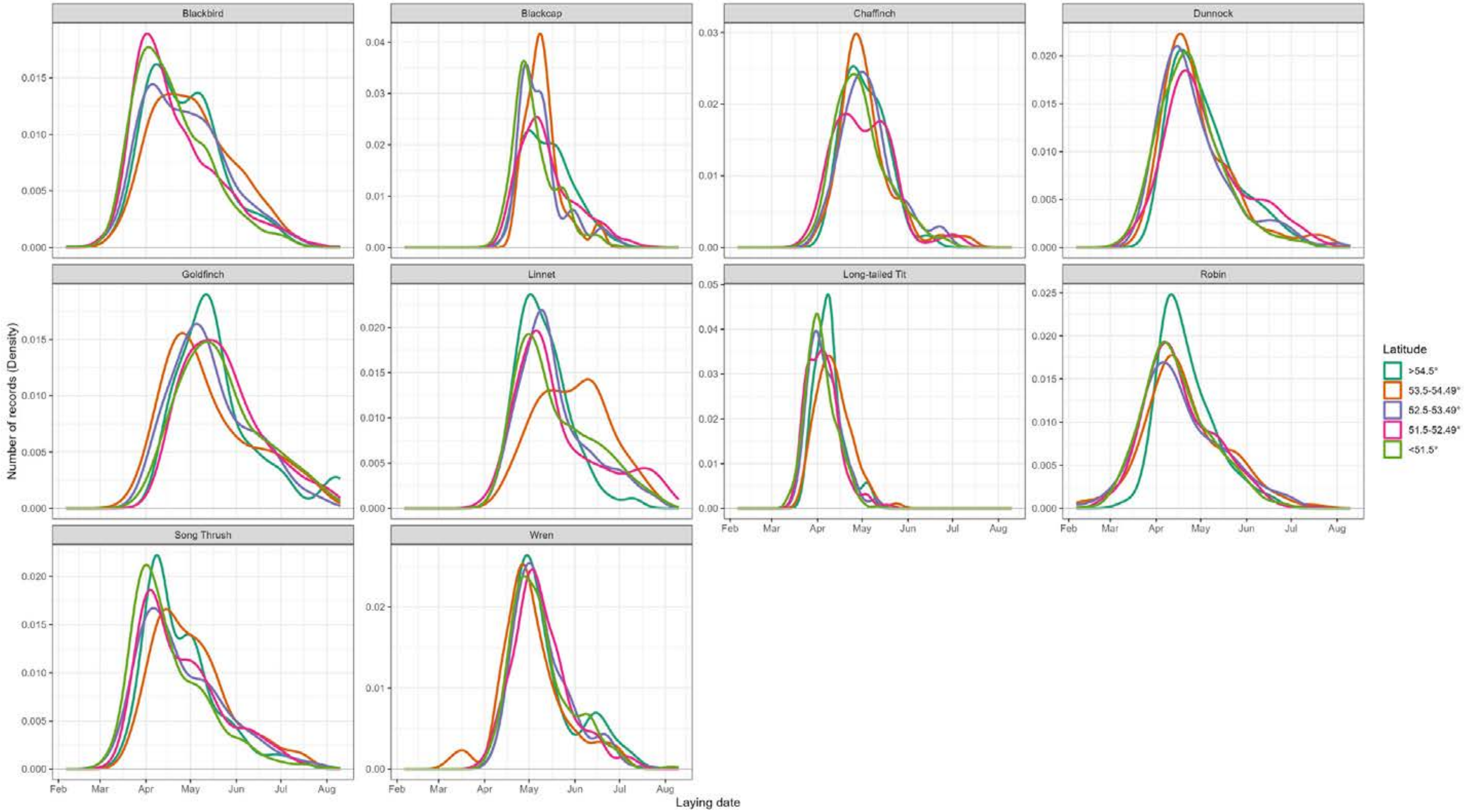


Table 7. 5th, 50th and 95th percentiles of the distributions of laying, fledging and independence dates in England between 2011–21 (excluding 2020), derived from the BTO/JNCC Nest Record Scheme dataset for two elevation bands, <200m and ≥200 m for species with more than 50 records in both elevation bands. To indicate overlap with current/potential management scenarios, dates extending into early August (1st–14th) are highlighted in yellow and those extending into late August (15th–31st) are highlighted in orange.

Species	Elevation band	First egg laying date percentiles			Fledging date percentiles			Post-fledging independence date percentiles			Number of records
		5th	50th	95th	5th	50th	95th	5th	50th	95th	
Blackbird	<200m	18-Mar	17-Apr	14-Jun	19-Apr	19-May	16-Jul	14-May	13-Jun	10-Aug	3,774
	≥200m	20-Mar	23-Apr	18-Jun	21-Apr	25-May	20-Jul	16-May	19-Jun	14-Aug	255
Chaffinch	<200m	06-Apr	28-Apr	05-Jun	06-May	28-May	05-Jul	27-May	18-Jun	26-Jul	389
	≥200m	16-Apr	04-May	03-Jun	16-May	03-Jun	03-Jul	06-Jun	24-Jun	24-Jul	72
Linnet	<200m	16-Apr	11-May	13-Jul	17-May	11-Jun	13-Aug	31-May	25-Jun	27-Aug	880
	≥200m	20-Apr	09-May	11-Jul	21-May	09-Jun	11-Aug	04-Jun	23-Jun	25-Aug	155
Long-tailed Tit	<200m	21-Mar	03-Apr	24-Apr	29-Apr	12-May	02-Jun	13-May	26-May	16-Jun	862
	≥200m	25-Mar	07-Apr	04-May	03-May	16-May	12-Jun	17-May	30-May	26-Jun	50
Robin	<200m	12-Mar	12-Apr	31-May	14-Apr	15-May	03-Jul	08-May	08-Jun	27-Jul	1,225
	≥200m	20-Mar	17-Apr	31-May	22-Apr	20-May	03-Jul	16-May	13-Jun	27-Jul	93
Song Thrush	<200m	21-Mar	15-Apr	17-Jun	22-Apr	17-May	19-Jul	13-May	07-Jun	09-Aug	1,697
	≥200m	23-Mar	22-Apr	09-Jun	24-Apr	24-May	11-Jul	15-May	13-Jun	01-Aug	136

Figure 6. Density plot of laying dates for sites a) below 200 m elevation, and b) equal to or over 200 m elevation, for all species for which at least 50 BTO/JNCC Nest Record Scheme records in both elevation bands over the study period in England. N=sample size. For the equivalent fledging and independence density plots, see Appendix 7.

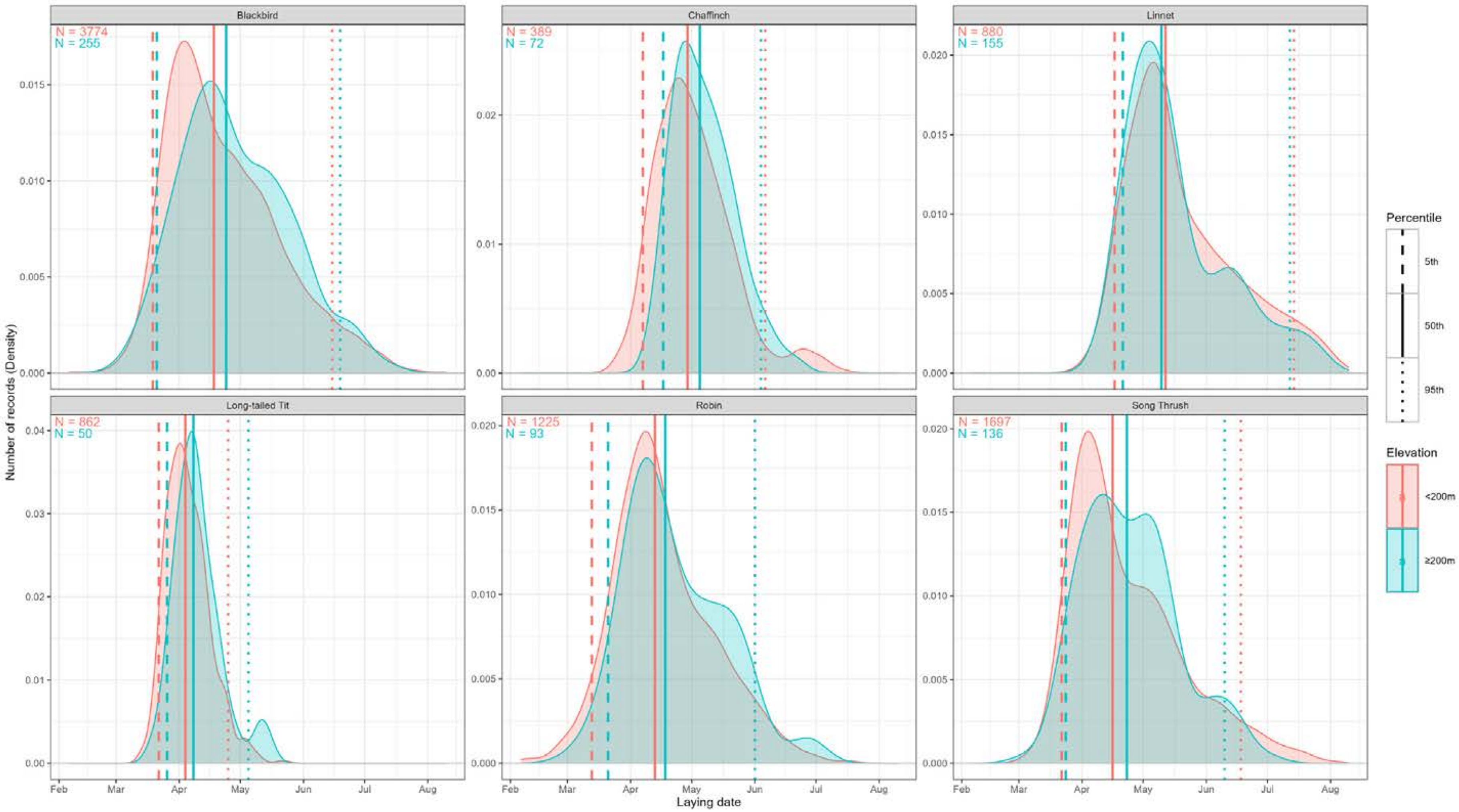


Table 8. 5th, 50th and 95th percentiles of the distributions of laying, fledging and independence dates in England between 2011–21 (excluding 2020), derived from the BTO/JNCC Nest Record Scheme dataset, generated independently for the volunteer-defined habitat categories 'farmland', 'human sites', 'scrubland' and 'woodland'. Habitat categories with fewer the 50 records are written in grey. To indicate overlap with current/potential management scenarios, dates extending into early August (1st–14th) are highlighted in yellow, those extending into late August (15th–31st) are highlighted in orange, and those extending into early September (1st–14th) are highlighted in red.

Species	Habitat – local	first egg laying date percentiles			fledging date percentiles			post-fleding independence percentiles			Number of records
		5th	50th	95th	5th	50th	95th	5th	50th	95th	
Blackbird	Farmland	21-Mar	19-Apr	23-Jun	22-Apr	21-May	25-Jul	17-May	15-Jun	19-Aug	437
	Human Sites	16-Mar	20-Apr	18-Jun	17-Apr	22-May	20-Jul	12-May	16-Jun	14-Aug	1,980
	Scrubland	24-Mar	16-Apr	15-Jun	25-Apr	18-May	17-Jul	20-May	12-Jun	11-Aug	343
	Woodland	20-Mar	13-Apr	07-Jun	21-Apr	15-May	09-Jul	16-May	09-Jun	03-Aug	1,084
Blackcap	Farmland	15-Apr	04-May	11-Jun	14-May	02-Jun	10-Jul	04-Jun	23-Jun	31-Jul	63
	Human Sites	18-Apr	03-May	25-May	17-May	01-Jun	23-Jun	07-Jun	22-Jun	14-Jul	50
	Scrubland	19-Apr	06-May	10-Jun	18-May	04-Jun	09-Jul	08-Jun	25-Jun	30-Jul	173
	Woodland	18-Apr	06-May	17-Jun	17-May	04-Jun	16-Jul	07-Jun	25-Jun	06-Aug	486
Chaffinch	Farmland	08-Apr	26-Apr	25-May	08-May	26-May	24-Jun	29-May	16-Jun	15-Jul	107
	Human Sites	03-Apr	30-Apr	27-May	03-May	30-May	26-Jun	24-May	20-Jun	17-Jul	103
	Scrubland	07-Apr	28-Apr	23-Jun	07-May	28-May	23-Jul	28-May	18-Jun	13-Aug	77
	Woodland	08-Apr	30-Apr	09-Jun	08-May	30-May	09-Jul	29-May	20-Jun	30-Jul	119
Dunnock	Farmland	31-Mar	23-Apr	01-Jul	01-May	24-May	01-Aug	18-May	10-Jun	18-Aug	103
	Human Sites	22-Mar	18-Apr	16-Jun	22-Apr	19-May	17-Jul	09-May	05-Jun	03-Aug	290
	Scrubland	08-Apr	26-Apr	15-Jun	09-May	28-May	16-Jul	26-May	13-Jun	02-Aug	134
	Woodland	31-Mar	25-Apr	21-Jun	01-May	26-May	22-Jul	18-May	12-Jun	08-Aug	154
Linnet	Farmland	18-Apr	27-May	24-Jul	19-May	27-Jun	24-Aug	02-Jun	11-Jul	07-Sep	214
	Human Sites	26-Apr	14-May	16-Jul	27-May	13-Jun	16-Aug	10-Jun	27-Jun	30-Aug	36
	Scrubland	16-Apr	08-May	07-Jul	17-May	08-Jun	07-Aug	31-May	22-Jun	21-Aug	317
	Woodland	12-Apr	09-May	10-Jul	13-May	09-Jun	10-Aug	27-May	23-Jun	24-Aug	69
Long-tailed Tit	Farmland	22-Mar	06-Apr	23-Apr	30-Apr	15-May	01-Jun	14-May	29-May	15-Jun	127
	Human Sites	21-Mar	02-Apr	28-Apr	29-Apr	11-May	06-Jun	13-May	25-May	20-Jun	135
	Scrubland	23-Mar	05-Apr	26-Apr	01-May	14-May	04-Jun	15-May	28-May	18-Jun	194
	Woodland	19-Mar	02-Apr	22-Apr	27-Apr	11-May	31-May	11-May	25-May	14-Jun	345

Robin	Farmland	19-Mar	15-Apr	08-Jun	21-Apr	18-May	11-Jul	15-May	11-Jun	04-Aug	120
	Human Sites	10-Mar	09-Apr	29-May	12-Apr	12-May	01-Jul	06-May	05-Jun	25-Jul	773
	Scrubland	28-Mar	15-Apr	03-Jun	30-Apr	18-May	06-Jul	24-May	11-Jun	30-Jul	59
	Woodland	21-Mar	16-Apr	31-May	23-Apr	19-May	03-Jul	17-May	12-Jun	27-Jul	306
Song Thrush	Farmland	22-Mar	15-Apr	17-Jun	23-Apr	17-May	19-Jul	14-May	07-Jun	09-Aug	214
	Human Sites	20-Mar	19-Apr	19-Jun	21-Apr	21-May	21-Jul	12-May	11-Jun	11-Aug	335
	Scrubland	22-Mar	16-Apr	14-Jun	23-Apr	18-May	16-Jul	14-May	07-Jun	06-Aug	328
	Woodland	21-Mar	13-Apr	12-Jun	22-Apr	15-May	14-Jul	13-May	05-Jun	04-Aug	849
Whitethroat	Farmland	26-Apr	18-May	05-Jul	26-May	17-Jun	04-Aug	15-Jun	07-Jul	24-Aug	84
	Human Sites	03-May	20-May	01-Jul	02-Jun	19-Jun	31-Jul	22-Jun	09-Jul	20-Aug	19
	Scrubland	30-Apr	14-May	18-Jun	30-May	13-Jun	18-Jul	19-Jun	03-Jul	07-Aug	100
	Woodland	30-Apr	16-May	25-Jun	30-May	15-Jun	25-Jul	19-Jun	05-Jul	14-Aug	12
Wren	Farmland	14-Apr	04-May	29-Jun	22-May	11-Jun	06-Aug	09-Jun	29-Jun	24-Aug	70
	Human Sites	13-Apr	05-May	21-Jun	21-May	12-Jun	29-Jul	08-Jun	30-Jun	16-Aug	151
	Scrubland	13-Apr	04-May	11-Jun	21-May	11-Jun	19-Jul	08-Jun	29-Jun	06-Aug	89
	Woodland	12-Apr	05-May	15-Jun	20-May	12-Jun	23-Jul	07-Jun	30-Jun	10-Aug	408

Figure 7. Density plot of laying dates for sites located in a) farmland, b) human sites, c) scrubland and d) woodland, as defined by the recorder using the standardised Crick coding system, for all species with at least 50 BTO/JNCC Nest Record Scheme records from farmland and scrubland sites, over the study period in England. N=sample size. For the equivalent fledging and independence density plots see Appendix 8.

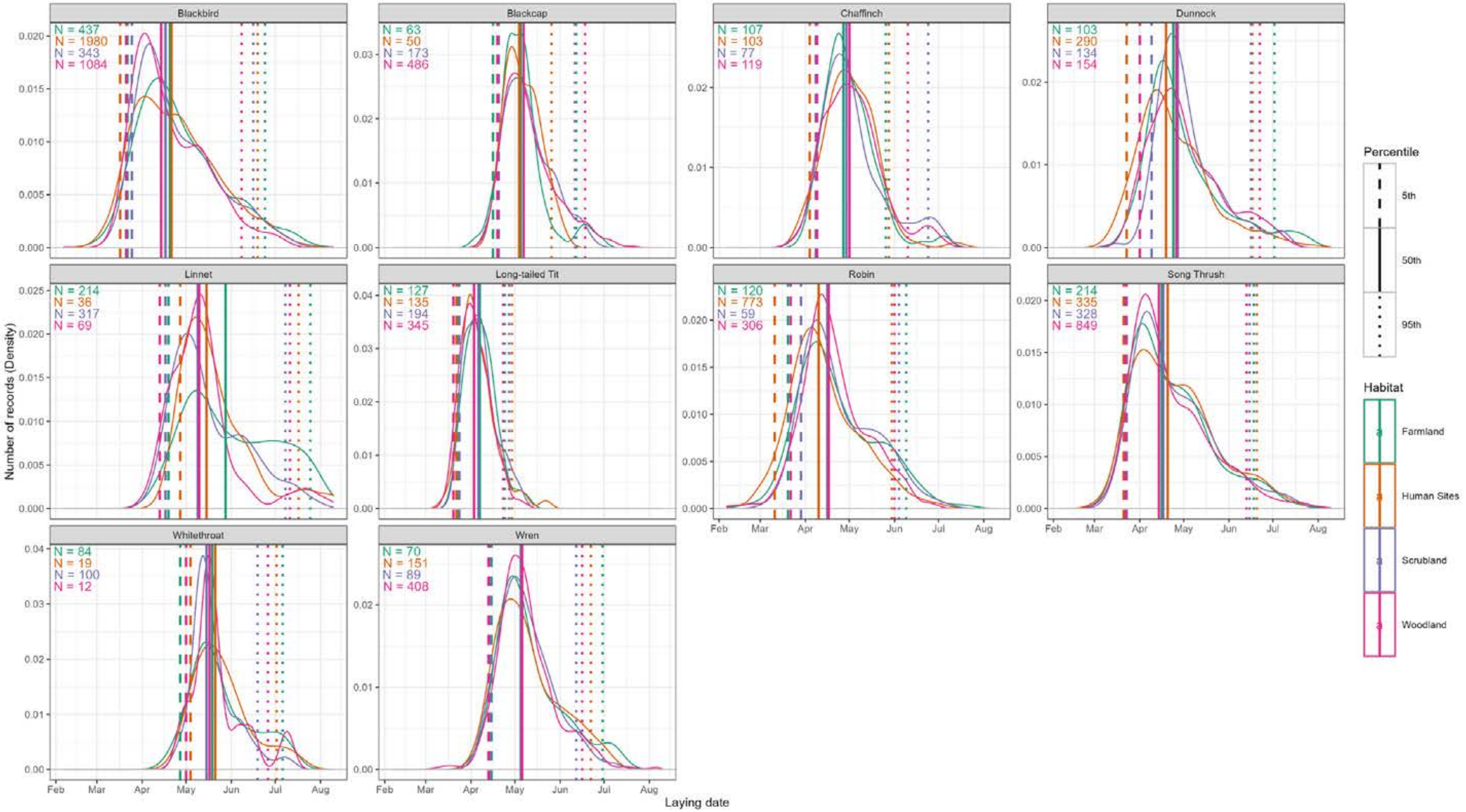
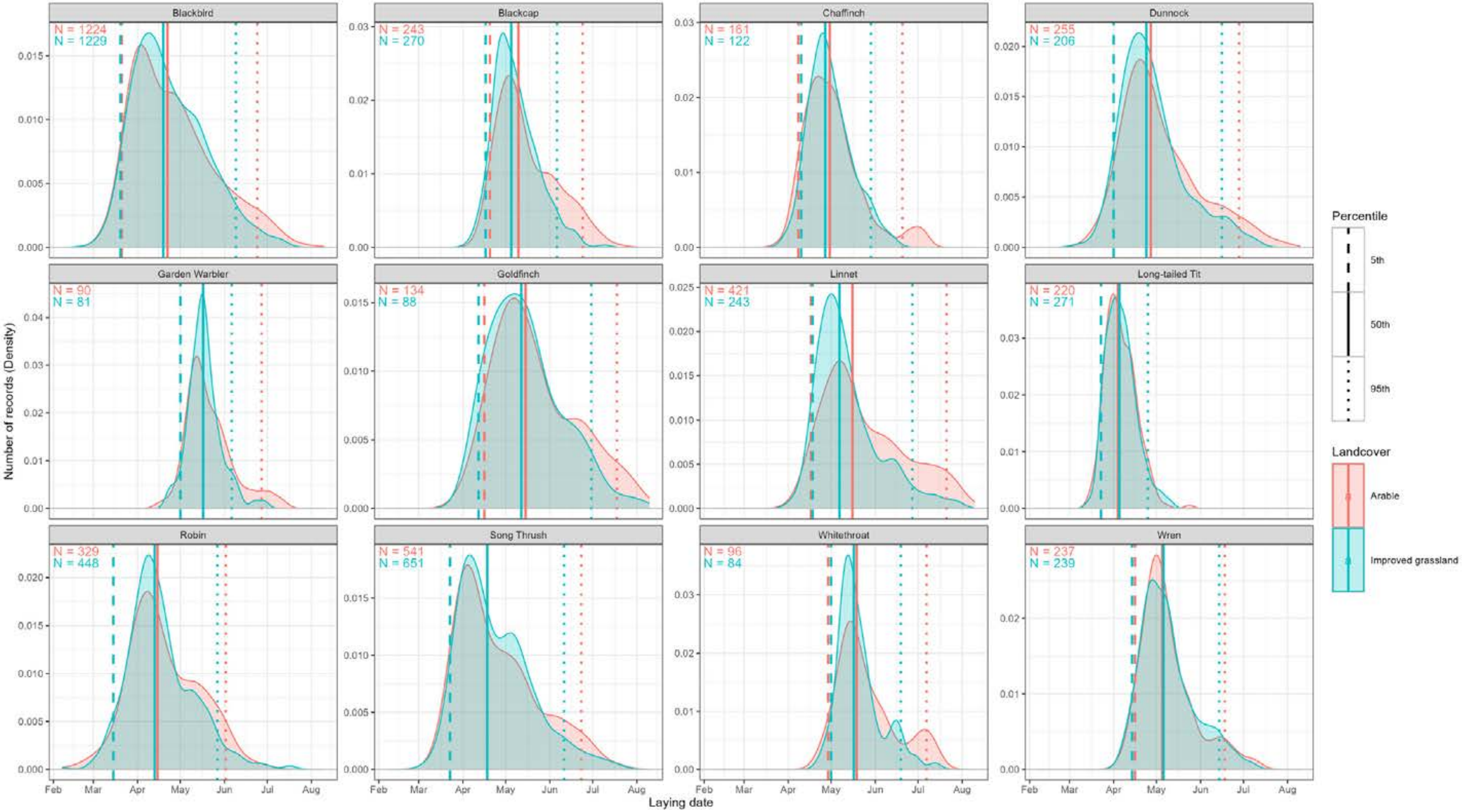


Table 9. 5th, 50th and 95th percentiles of the distributions of laying, fledging and independence dates in England between 2011–21 (excluding 2020), derived from the BTO/JNCC Nest Record Scheme dataset, for data originating from landscapes (1 km Ordnance Survey squares) dominated by either arable or improved grassland land cover. To indicate overlap with current/potential management scenarios, dates extending into early August (1st–14th) are highlighted in yellow, those extending into late August (15th–31st) are highlighted in orange, and those extending into early September (1st–14th) are highlighted in red.

Species	Dominant landscape land cover	First egg laying date percentiles			Fledging date percentiles			Post-fleding independence date percentiles			Number of records
		5th	50th	95th	5th	50th	95th	5th	50th	95th	
Blackbird	Arable	20-Mar	21-Apr	23-Jun	21-Apr	23-May	25-Jul	16-May	17-Jun	19-Aug	1,225
	Improved grassland	19-Mar	18-Apr	08-Jun	20-Apr	20-May	10-Jul	15-May	14-Jun	04-Aug	1,229
Blackcap	Arable	19-Apr	09-May	23-Jun	18-May	07-Jun	22-Jul	08-Jun	28-Jun	12-Aug	243
	Improved grassland	16-Apr	04-May	05-Jun	15-May	02-Jun	04-Jul	05-Jun	23-Jun	25-Jul	270
Chaffinch	Arable	07-Apr	29-Apr	19-Jun	07-May	29-May	19-Jul	28-May	19-Jun	09-Aug	161
	Improved grassland	09-Apr	26-Apr	28-May	09-May	26-May	27-Jun	30-May	16-Jun	18-Jul	122
Dunnock	Arable	31-Mar	26-Apr	27-Jun	01-May	27-May	28-Jul	18-May	13-Jun	14-Aug	255
	Improved grassland	31-Mar	23-Apr	15-Jun	01-May	24-May	15-Jul	18-May	10-Jun	02-Aug	206
Garden Warbler	Arable	30-Apr	16-May	26-Jun	27-May	12-Jun	23-Jul	10-Jun	26-Jun	06-Aug	90
	Improved grassland	30-Apr	16-May	05-Jun	27-May	12-Jun	02-Jul	10-Jun	26-Jun	16-Jul	81
Goldfinch	Arable	15-Apr	14-May	17-Jul	19-May	17-Jun	20-Aug	29-May	27-Jun	30-Aug	134
	Improved grassland	11-Apr	11-May	29-Jun	15-May	14-Jun	02-Aug	25-May	24-Jun	12-Aug	88
Linnet	Arable	16-Apr	15-May	20-Jul	17-May	15-Jun	20-Aug	31-May	29-Jun	03-Sep	421
	Improved grassland	17-Apr	06-May	26-Jun	18-May	06-Jun	27-Jul	01-Jun	20-Jun	10-Aug	243
Long-tailed Tit	Arable	22-Mar	03-Apr	24-Apr	30-Apr	12-May	02-Jun	14-May	26-May	16-Jun	220
	Improved grassland	22-Mar	04-Apr	24-Apr	30-Apr	13-May	03-Jun	14-May	27-May	17-Jun	271
Robin	Arable	14-Mar	14-Apr	01-Jun	16-Apr	17-May	04-Jul	10-May	10-Jun	28-Jul	329
	Improved grassland	14-Mar	12-Apr	26-May	16-Apr	15-May	28-Jun	10-May	08-Jun	22-Jul	448
Song Thrush	Arable	22-Mar	17-Apr	22-Jun	23-Apr	19-May	24-Jul	14-May	09-Jun	14-Aug	541
	Improved grassland	22-Mar	17-Apr	10-Jun	23-Apr	19-May	12-Jul	14-May	09-Jun	02-Aug	651
Whitethroat	Arable	28-Apr	18-May	06-Jul	28-May	17-Jun	05-Aug	17-Jun	07-Jul	25-Aug	96
	Improved grassland	30-Apr	16-May	18-Jun	30-May	15-Jun	18-Jul	19-Jun	05-Jul	07-Aug	84
Wren	Arable	15-Apr	04-May	17-Jun	23-May	11-Jun	25-Jul	10-Jun	29-Jun	12-Aug	237
	Improved grassland	13-Apr	05-May	13-Jun	21-May	12-Jun	21-Jul	08-Jun	30-Jun	08-Aug	239

Figure 8. Density plot of laying dates for landscapes (1 km Ordnance Survey squares) dominated by a) arable or b) improved grassland, as defined by Land Cover Map data (Rowland et al. 2017), for all species with at least 50 BTO/JNCC Nest Record Scheme records from both landscape categories, over the study period in England. N=sample size. For the equivalent fledging and independence density plots, see Appendix 8.



4. Discussion and summary

The key finding from this report is that very few nests are still active (i.e. contain live eggs or chicks) when the current hedgerow management suspension period ends at the start of September. NRS data indicate that active nests are only likely to be present for 6/15 species by this stage of the season, and that these nests account for <2% of the annual monitoring sample for any of these species. These results suggest that the probability of direct nest destruction under the management protocols currently mandated is relatively low.

Hedgerow management may also incur risks to young birds after they have fledged; many songbird species continue to care for young for several weeks after they leave the nest, during which time the fledglings are unable to fly well, cannot cross significant gaps in the vegetation and may struggle to avoid threats, relying on thick cover to protect themselves from predators and the weather (Vitz & Rodewald 2011, Small et al. 2015). Under current legislation, the risk of impact on fledglings, either directly through injury or indirectly via reduction in food or shelter, is higher than the risk to active nests, but fewer than 10% of pairs of any species included in this analysis are still caring for dependent young after the beginning of September.

Should hedgerow management be permitted from the beginning of August, estimates of breeding phenology presented here indicate that the number of nests at risk of damage by machinery is likely to increase substantially. Of the 15 species include in the analysis, nests of 14 are still likely to be active at this point, representing a proportion of annual attempts that ranges from 0.4% for Robin to 26% for Yellowhammer, a farmland bird indicator species on the Birds of Conservation Concern (BoCC; Stanbury et al. 2021) Red List. The BoCC Red-listed Linnet and BoCC Amber-listed Bullfinch are two other species where risk of nest damage is likely to increase substantially under this management scenario, with 10% of the annual total of nests of both species still active in the first half of August. If the hedgerow management suspension period were moved to end in mid August, rather than at the start of the month, 12% of Yellowhammer, 4% of Linnet and 4% of Bullfinch annual breeding attempts would be at risk of damage from cutting and flailing activity.

Indirect impacts of hedgerow management during August may also be significant. With the exception of Long-tailed Tit, some adults of all species included in this study will be caring for dependent young during the first half of August, the proportion being particularly high for Yellowhammer (38%), Bullfinch (27%), Linnet (16%), the BoCC Green-listed Goldfinch (16%), another farmland bird indicator species, and the BoCC Amber-listed Whitethroat (13%), also included in the farmland bird indicator suite. These figures are lower in the second half of August but remain reasonably high (27%, 16%, 10%, 8% and 7% respectively); by the time the current management suspension is lifted, they have fallen below 5% for all species except Yellowhammer (9%).

Breeding phenology may vary over time and space, which might impact the transferability of regulations based on national data to specific regions. While a comprehensive multivariate analysis was beyond the scope of this project, we explored the influence of year, latitude, elevation and habitat on laying date distributions by sub-setting the data and estimating percentiles independently for each subset, then assessing the range of 95th percentile estimates, given that the end of the season is the period of interest with respect to hedgerow management regulation.

Over the 10 years of data analysed, annual variation exhibited in the 95th percentile was approximately +/- one week across all species and the difference in estimates produced for southern and northern England was a week or less for 12/13 species; likewise, the difference between 95th percentile estimates between latitude bands for the majority of species was a week or less. Variation between habitat types was potentially slightly greater, with a maximum difference of 10 days between 95th percentile estimates based for dominant habitat type classifications derived from LCM data but, in general, the magnitude of annual and latitudinal variation, at least over this time period, appears to be relatively limited. A more robust, multivariate analysis would be needed to accurately quantify the contribution of each of these variables to variation in laying phenology, as these environmental factors are likely to exhibit some degree of correlation, noting that the limited range of latitudes and elevations represented in the dataset may limit statistical power.

Volunteer effort is not standardised for either the NRS or the Ringing Scheme and may therefore vary across the season. The most likely bias is towards earlier nesting attempts, which are more detectable as the vegetation is yet to fully develop, and volunteer fatigue is also likely to be a factor, though possibly less so for specialist species such as Bullfinch, Linnet and Yellowhammer, where observers are targeting breeding pairs rather than relying on incidental encounter. As such, the estimates of 95th percentiles presented in this study may represent an underestimate of the true situation and should be considered conservative. In addition, to better quantify the impact of various management scenarios, one would ideally take into account the relative contributions of early and late broods to the overall population. In some species, clutch and brood sizes tend to decrease over the course of the breeding season/attempts (Moss et al. 2005, Newson et al. 2007) which may mean late broods/clutches contribute fewer recruits, though this may be compensated for by reduced failure rates as nests become more concealed due to vegetation growth (Anderson, 2014). Furthermore, this report does not consider the wider conservation implications of earlier hedgerow cutting, such as impacts on overwinter berry supplies or the future structure of the hedges themselves, noting that autumn cutting potentially leads to a reduction in flowering and berry mass the following year compared to winter cutting (Staley et al. 2012, Graham et al. 2018).

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Appendices

Appendix 1. Spatial distribution of focal species records from the BTO/JNCC Nest Record Scheme and BTO Ringing Scheme.

Figure A1.1. Maps of the distribution and density of all Nest Record Scheme data for the period 2011–21, excluding 2020 for all focal species in England. The red dashed line marks 53° latitude which was used to divide records into North and South, while the red and blue bands show the five latitudinal bands used for more detailed consideration of the impact of latitude on phenology. N=scheme sample size.

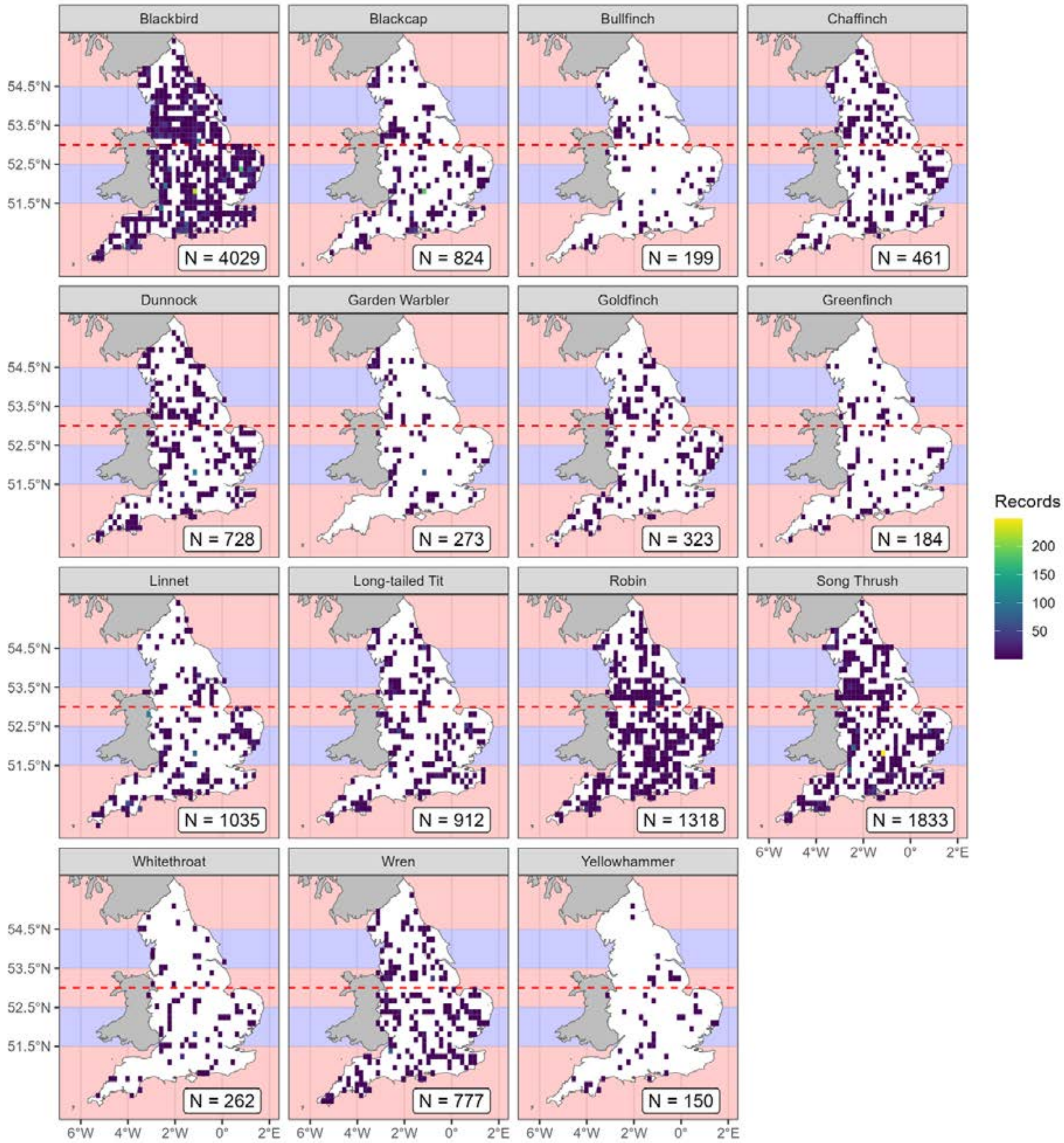


Figure A1.2. Maps of the distribution and density of all pullus ringing records from the Ringing Scheme for the period 2011–21, excluding 2020 for all focal species in England. The red dashed line marks 53° latitude which was used to divide records into North and South, while the red and blue bands show the five latitudinal bands used for more detailed consideration of the impact of latitude on phenology. N=scheme sample size.

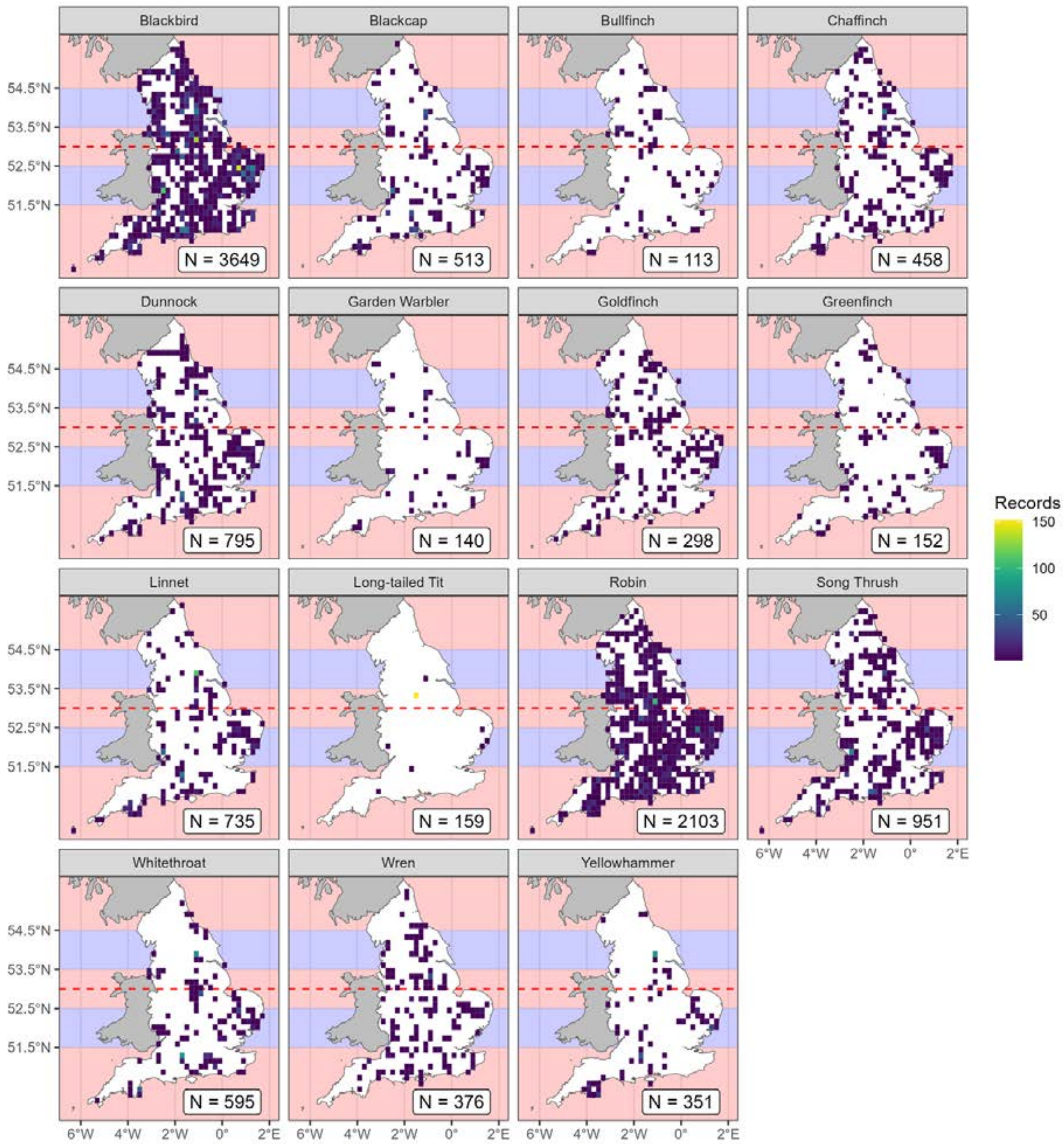
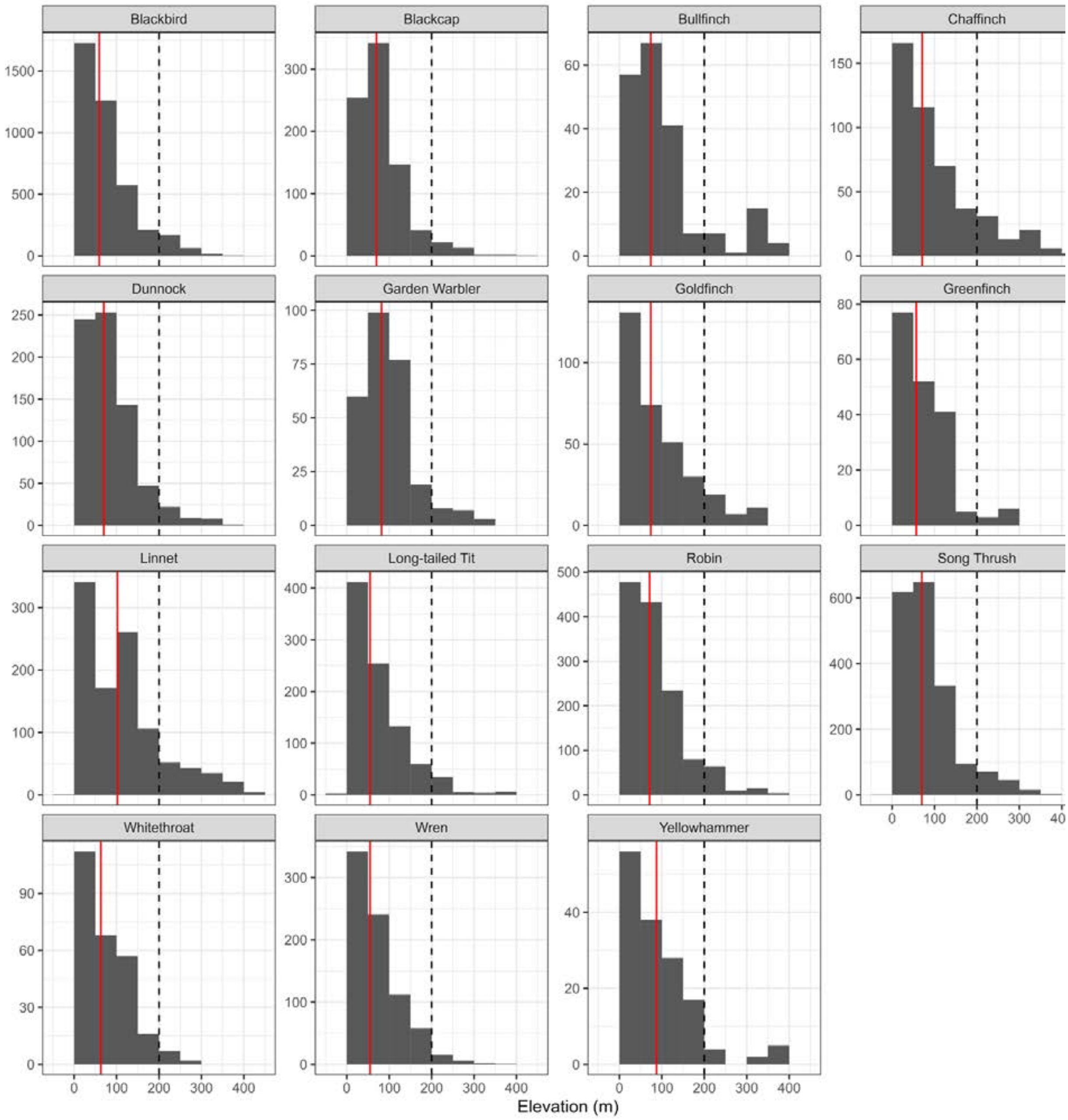


Figure A1.3. Histograms of the distribution of all Nest Record Scheme records by Ordnance Survey 1-km square mean elevation (metres above sea level). Elevation is presented in 50 m bins, the vertical red line marks the median elevation and the black dashed line 200 m which was used to divide lower and higher elevations. Note a small number of primarily coastal records came from grid reference squares with mean elevations below sea level. N=sample size.



Appendix 2. Comparing scheme nesting phenology estimates using independent datasets

Figure A2.1. Boxplots showing the distribution of laying date estimates derived from breeding attempts monitored by the Nest Record Scheme and Ringing Scheme at independent sites. "Whiskers" indicate the 5th and 95th percentile estimates; points relate to individual estimates that fall outside either the 1st or 99th percentiles. The value of the adjusted p value from the Mann Whitney U tests indicated by: ns p > 0.05, * p <0.05, ** p <0.01, *** p < 0.001. N = scheme sample size.

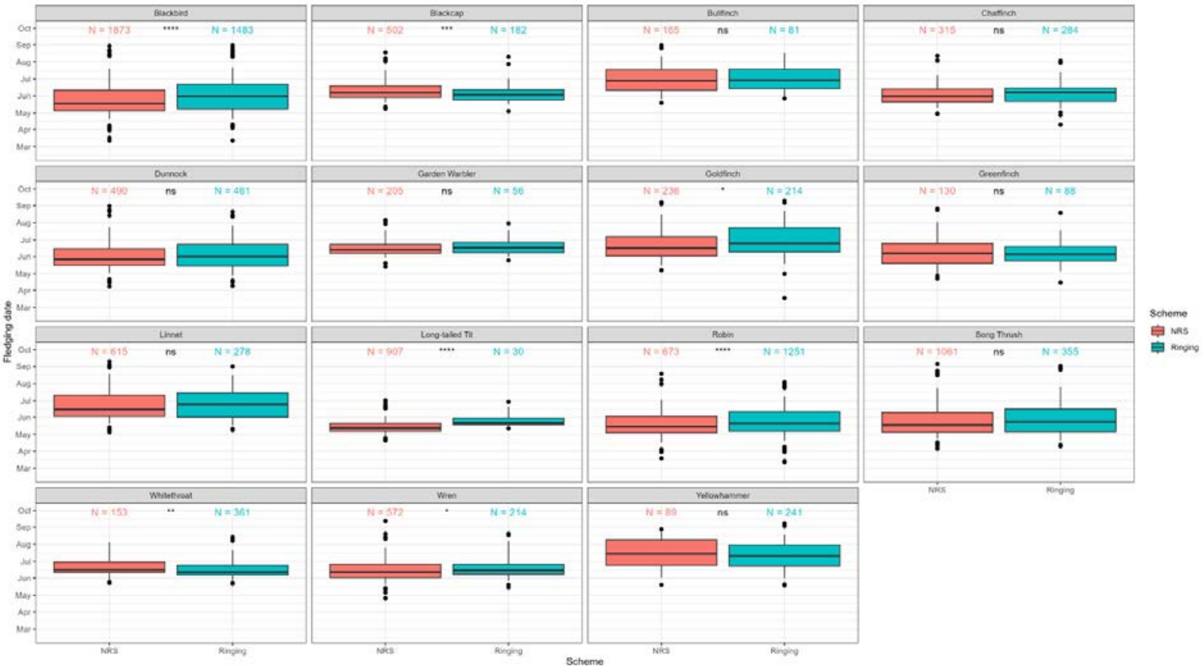


Figure A2.2. Density plots of the distribution of laying date estimates derived from independent sites from breeding attempts monitored by the Nest Record Scheme and Ringing Scheme. N=scheme sample size.

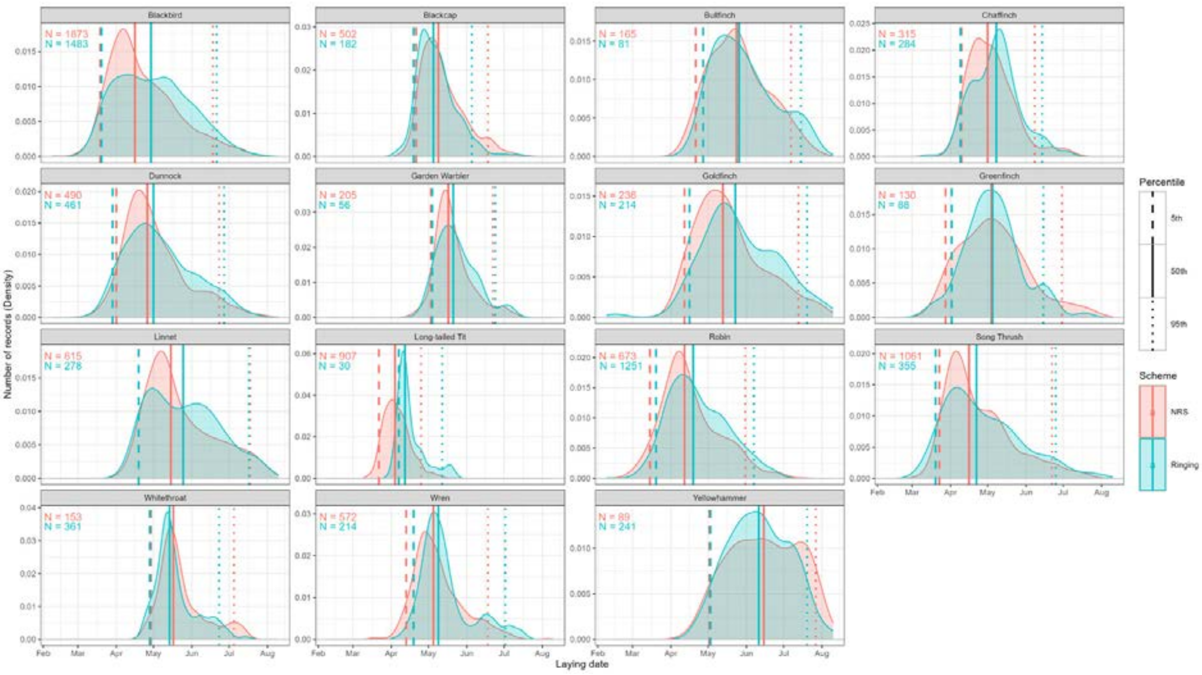


Table A2.1. Comparing the focal species percentile estimates for laying date and 95th percentile estimates for fledging dates between nests monitored by the BTO/ Nest Record Scheme and Ringing Scheme derived from independent sites. Estimate differences where the NRS scheme estimates where earlier are highlighted in red and where it was later are highlighted in blue.

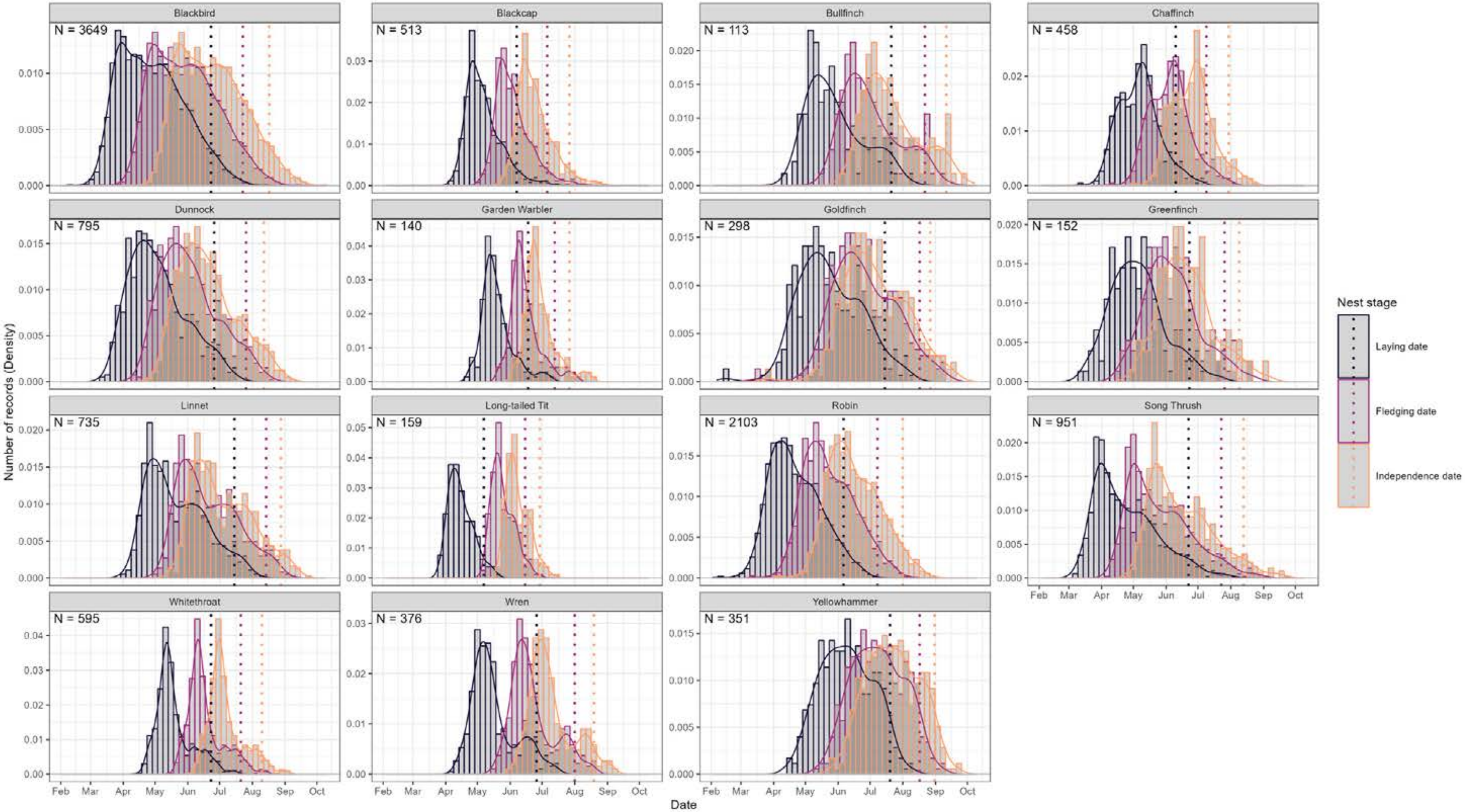
	Scheme						Percentile estimate difference			Mann-Whitney U test results		Sample size	
	NRS			Ringing									
Species	5th	50th	95th	5th	50th	95th	5th	50th	95th	U	Adjusted P	NRS	Ringing
Blackbird	19-Mar	16-Apr	17-Jun	19-Mar	28-Apr	20-Jun	0	-12	-3	1157714	<0.001 ***	1,873	1,483
Blackcap	21-Apr	08-May	17-Jun	18-Apr	04-May	04-Jun	3	4	13	52667	0.022 *	502	182
Bullfinch	20-Apr	23-May	06-Jul	26-Apr	25-May	14-Jul	-6	-2	-8	6107	0.730	165	81
Chaffinch	09-Apr	30-Apr	07-Jun	08-Apr	07-May	13-Jun	1	-7	-6	38732	0.036 *	315	284
Dunnock	31-Mar	25-Apr	22-Jun	28-Mar	30-Apr	26-Jun	3	-5	-4	102788	0.110	490	461
Garden Warbler	03-May	16-May	21-Jun	03-May	20-May	23-Jun	0	-4	-2	5072	0.730	205	56
Goldfinch	12-Apr	12-May	12-Jul	15-Apr	22-May	19-Jul	-3	-10	-7	20627	0.009 **	236	214
Greenfinch	28-Mar	03-May	29-Jun	01-Apr	04-May	14-Jun	-4	-1	15	5718	1.000	130	88
Linnet	18-Apr	14-May	17-Jul	18-Apr	24-May	16-Jul	0	-10	1	80180	0.690	615	278
Long-tailed Tit	21-Mar	04-Apr	24-Apr	06-Apr	11-Apr	11-May	-16	-7	-17	6246	<0.001 ***	907	30
Robin	14-Mar	12-Apr	30-May	19-Mar	18-Apr	06-Jun	-5	-6	-7	358179	<0.001 ***	673	1251
Song Thrush	23-Mar	15-Apr	21-Jun	19-Mar	21-Apr	24-Jun	4	-6	-3	177820	0.690	1,061	355
Whitethroat	28-Apr	16-May	04-Jul	27-Apr	13-May	22-Jun	1	3	12	32098	0.032 *	153	361
Wren	12-Apr	04-May	17-Jun	18-Apr	08-May	01-Jul	-6	-4	-14	49977	<0.001 ***	572	214
Yellowhammer	02-May	14-Jun	26-Jul	02-May	10-Jun	19-Jul	0	4	7	11710	0.730	89	241

Appendix 3. Laying, hatching, fledging and post-fledging independence phenology summaries derived from pullus bird ringing data.

Table A3.1. The 5th, 50th, 95th and 100th percentiles for laying, fledging and post-fledging independence dates for all focal species between 2011–21 (excluding 2020) derived from pullus ringed under the Ringing scheme. To indicate overlap with current/potential management periods dates that fall withing the early August period (1st–14th) are highlighted in yellow, within the late August period (15th–31st) in orange, within the early September period (1st–14th) in red and on/after the 15th September period in purple.

	First egg laying date percentiles				Fledging date percentiles				Post-fledging independence date percentiles				Number of records
Species	5th	50th	95th	100th	5th	50th	95th	100th	5th	50th	95th	100th	
Blackbird	17-Mar	25-Apr	22-Jun	12-Aug	17-Apr	27-May	22-Jul	12-Sep	12-May	21-Jun	16-Aug	07-Oct	3,649
Blackcap	15-Apr	02-May	06-Jun	12-Jul	13-May	30-May	05-Jul	09-Aug	03-Jun	20-Jun	26-Jul	30-Aug	513
Bullfinch	26-Apr	24-May	20-Jul	06-Aug	30-May	26-Jun	21-Aug	08-Sep	19-Jun	16-Jul	10-Sep	28-Sep	113
Chaffinch	07-Apr	06-May	09-Jun	05-Jul	07-May	05-Jun	08-Jul	02-Aug	28-May	26-Jun	29-Jul	23-Aug	458
Dunnock	27-Mar	29-Apr	25-Jun	23-Jul	26-Apr	29-May	25-Jul	20-Aug	13-May	15-Jun	11-Aug	06-Sep	795
Garden Warbler	29-Apr	15-May	17-Jun	09-Jul	27-May	10-Jun	12-Jul	02-Aug	10-Jun	24-Jun	26-Jul	16-Aug	140
Goldfinch	14-Apr	18-May	14-Jul	08-Aug	17-May	21-Jun	16-Aug	09-Sep	27-May	01-Jul	26-Aug	19-Sep	298
Greenfinch	27-Mar	02-May	22-Jun	20-Jul	28-Apr	02-Jun	25-Jul	20-Aug	12-May	16-Jun	08-Aug	03-Sep	152
Linnet	16-Apr	14-May	14-Jul	08-Aug	16-May	14-Jun	13-Aug	06-Sep	30-May	28-Jun	27-Aug	20-Sep	735
Long-tailed Tit	30-Mar	12-Apr	06-May	19-May	11-May	22-May	14-Jun	28-Jun	25-May	05-Jun	28-Jun	12-Jul	159
Robin	18-Mar	17-Apr	05-Jun	10-Jul	19-Apr	20-May	07-Jul	11-Aug	13-May	13-Jun	31-Jul	04-Sep	2,103
Song Thrush	19-Mar	17-Apr	21-Jun	02-Aug	19-Apr	19-May	22-Jul	01-Sep	10-May	09-Jun	12-Aug	22-Sep	951
Whitethroat	26-Apr	13-May	22-Jun	17-Jul	26-May	11-Jun	20-Jul	14-Aug	15-Jun	01-Jul	09-Aug	03-Sep	595
Wren	18-Apr	09-May	25-Jun	16-Jul	26-May	15-Jun	31-Jul	19-Aug	13-Jun	03-Jul	18-Aug	06-Sep	376
Yellowhammer	29-Apr	08-Jun	19-Jul	09-Aug	29-May	07-Jul	16-Aug	07-Sep	12-Jun	21-Jul	30-Aug	21-Sep	351

Figure A3.1. Histograms and density plot of laying, fledging and post-fledging independence dates for all focal species between 2011–21 (excluding 2020), derived from pullus ringed under the Ringing Scheme, binned into five-day periods. The coloured vertical dashed lines indicate the 95th percentiles for the respective nest stages; N=sample size.



Appendix 4. Laying, fledging and post-fledging independence phenology overlap with management period summaries derived from the BTO Ringing Scheme pullus dataset.

Figure A4.1. Stacked histograms showing the percentage of all monitored nests that were active on any given day during the breeding season by nest stage for all focal species between 2011–21 (excluding 2020), as derived from the Ringing Scheme pullus dataset across all habitats. The vertical lines highlight key dates of current/potential hedgerow management scenarios with the lines for 1st August–15th September corresponding to percentages of nests remaining active reported in Table A4.1ii. N=sample size.

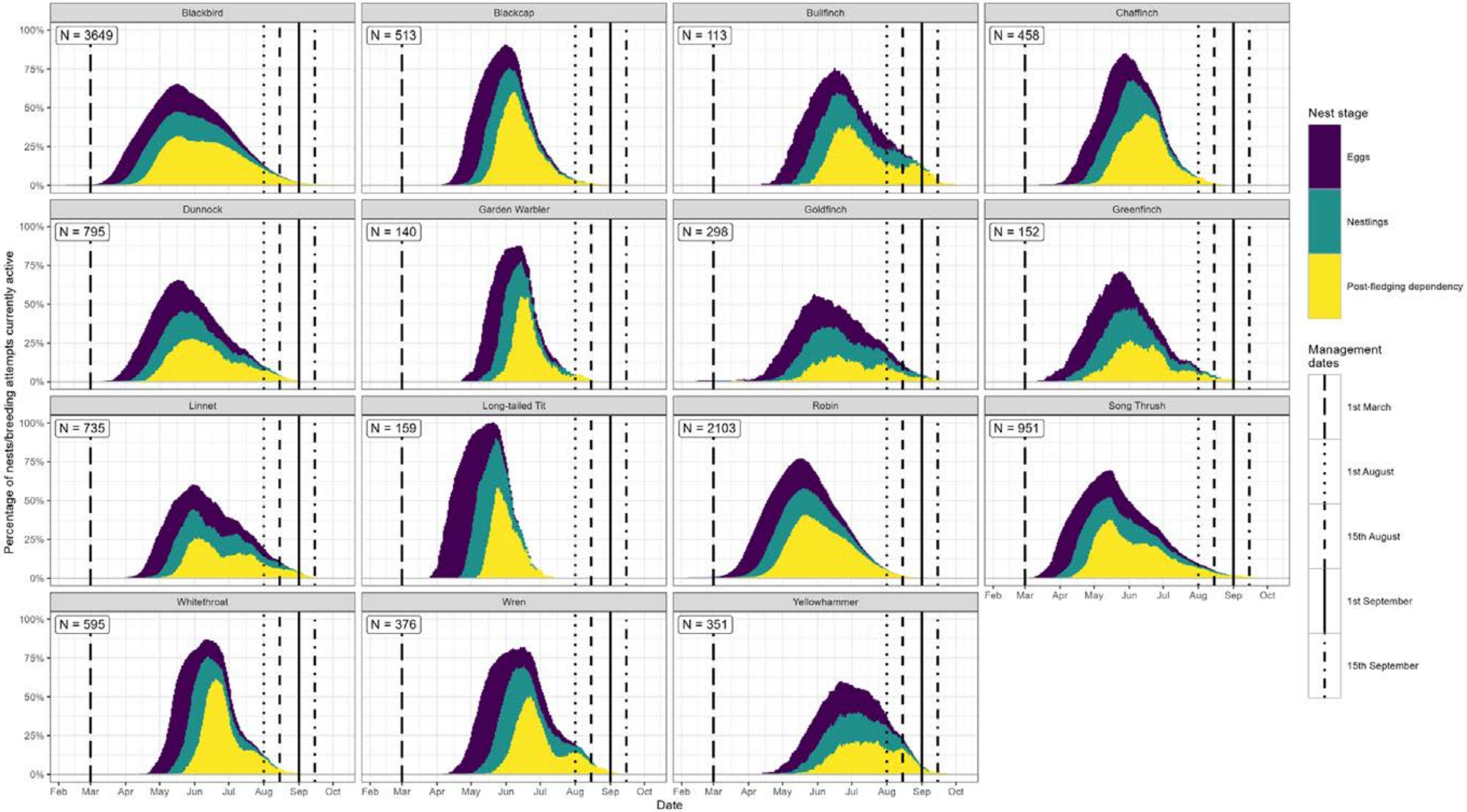


Table A4.1. The overall percentage of Ringing Scheme monitored nests that i) relate to nests still containing live eggs and/or chicks, or ii) relate to all active breeding attempts, a total that pools active nests and those that have fledged but where young are yet to reach independence, at the start of each of the current/potential hedgerow management scenario cut-off dates. Periods with more 5% of attempts remaining active are highlighted in orange, those with more than 10% in red and those with more than 20% in purple.

	i) Percentage of nests still alive				ii) Percentage of breeding attempts still active			
Species	1st Aug onwards	15th Aug onwards	1st Sept onwards	15th Sept onwards	1st Aug onwards	15th Aug onwards	1st Sept onwards	15th Sept onwards
Blackbird	2.4%	0.6%	0.0%	0.0%	12.2%	5.9%	1.5%	0.2%
Blackcap	0.4%	0.0%	0.0%	0.0%	3.1%	1.2%	0.0%	0.0%
Bullfinch	18.5%	9.7%	0.9%	0.0%	30.1%	20.4%	12.4%	1.8%
Chaffinch	0.2%	0.0%	0.0%	0.0%	4.8%	1.1%	0.0%	0.0%
Dunnock	2.4%	0.1%	0.0%	0.0%	9.7%	3.5%	0.1%	0.0%
Garden Warbler	0.7%	0.0%	0.0%	0.0%	4.3%	0.7%	0.0%	0.0%
Goldfinch	12.4%	5.7%	1.7%	0.0%	21.4%	11.0%	4.0%	1.0%
Greenfinch	3.9%	1.3%	0.0%	0.0%	7.2%	3.9%	1.3%	0.0%
Linnet	9.7%	4.0%	0.1%	0.0%	18.4%	9.8%	3.4%	0.1%
Long-tailed Tit	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Robin	0.2%	0.0%	0.0%	0.0%	4.6%	1.1%	0.0%	0.0%
Song Thrush	2.7%	1.4%	0.1%	0.0%	8.6%	4.2%	1.4%	0.6%
Whitethroat	1.3%	0.0%	0.0%	0.0%	11.4%	3.0%	0.5%	0.0%
Wren	5.1%	1.6%	0.0%	0.0%	18.4%	7.5%	1.6%	0.0%
Yellowhammer	21.7%	6.3%	0.9%	0.0%	35.7%	21.7%	4.3%	0.9%

Appendix 5. Northern and southern nesting phenology.

Figure A5.1. Density plot of fledging dates in northern and southern England, using 53°N as a dividing line, for all species for which at least 50 Nest Record Scheme records in both regions over the study period. N=sample size.

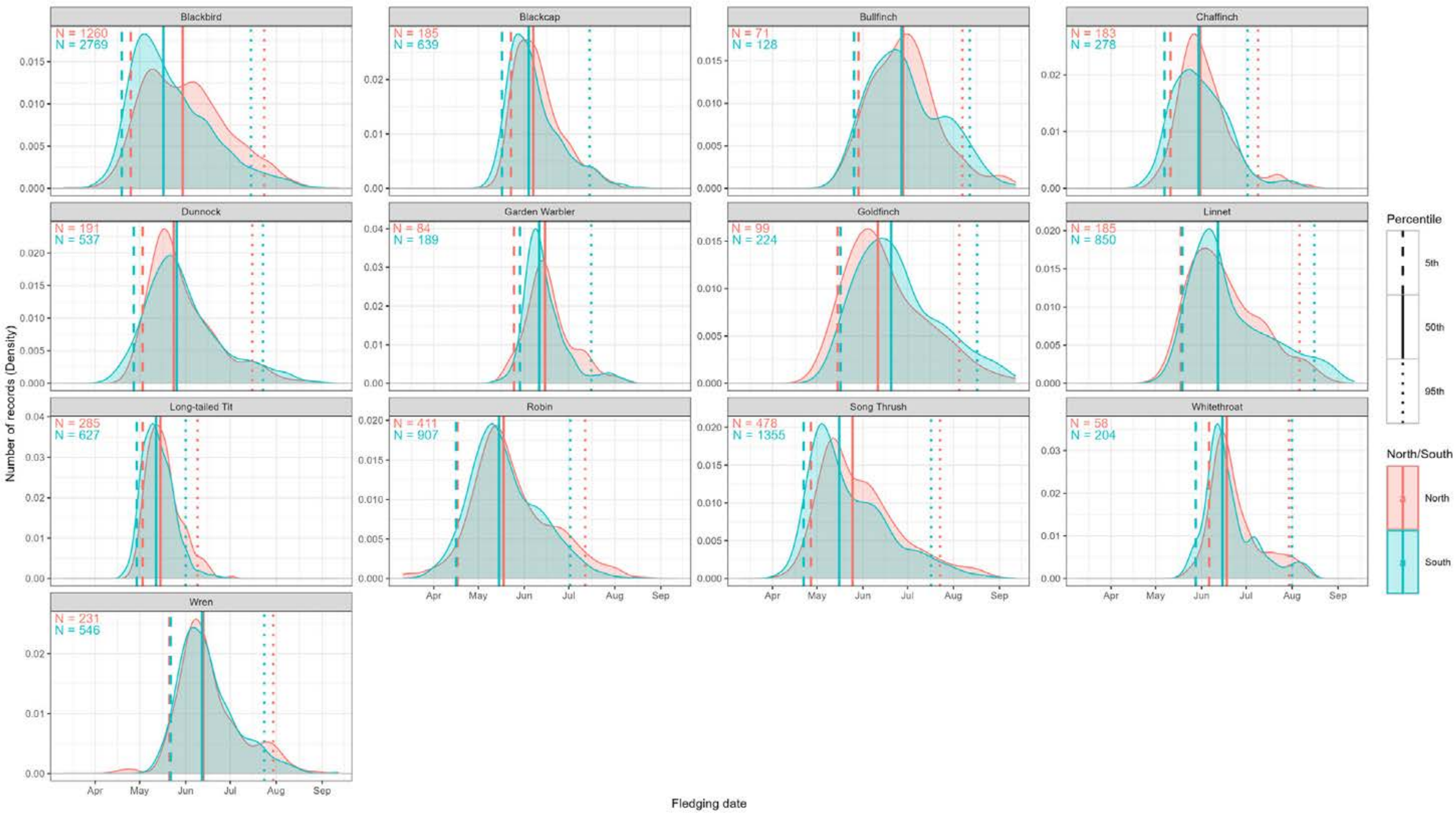
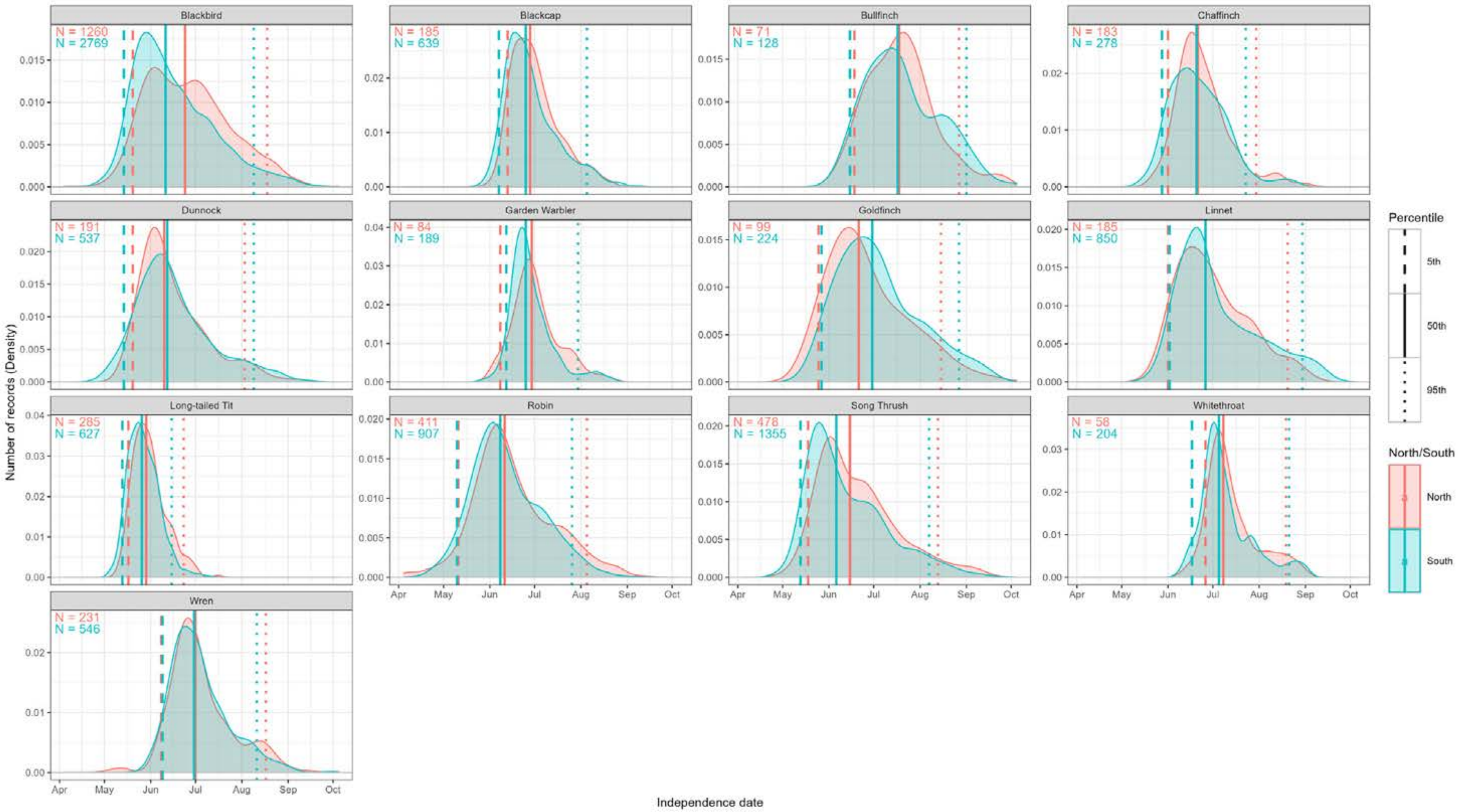


Figure A5.2. Density plot of independence dates in northern and southern England, using 53°N as a dividing line, for all species for which at least 50 Nest Record Scheme records in both regions over the study period. N=sample size.



Appendix 6. Nesting phenology by latitude band.

Figure A6.1. Density plot of fledging dates by latitude band in England for all species for which at least 50 Nest Record Scheme records have been submitted from at least three of the five latitude bands over the study period.

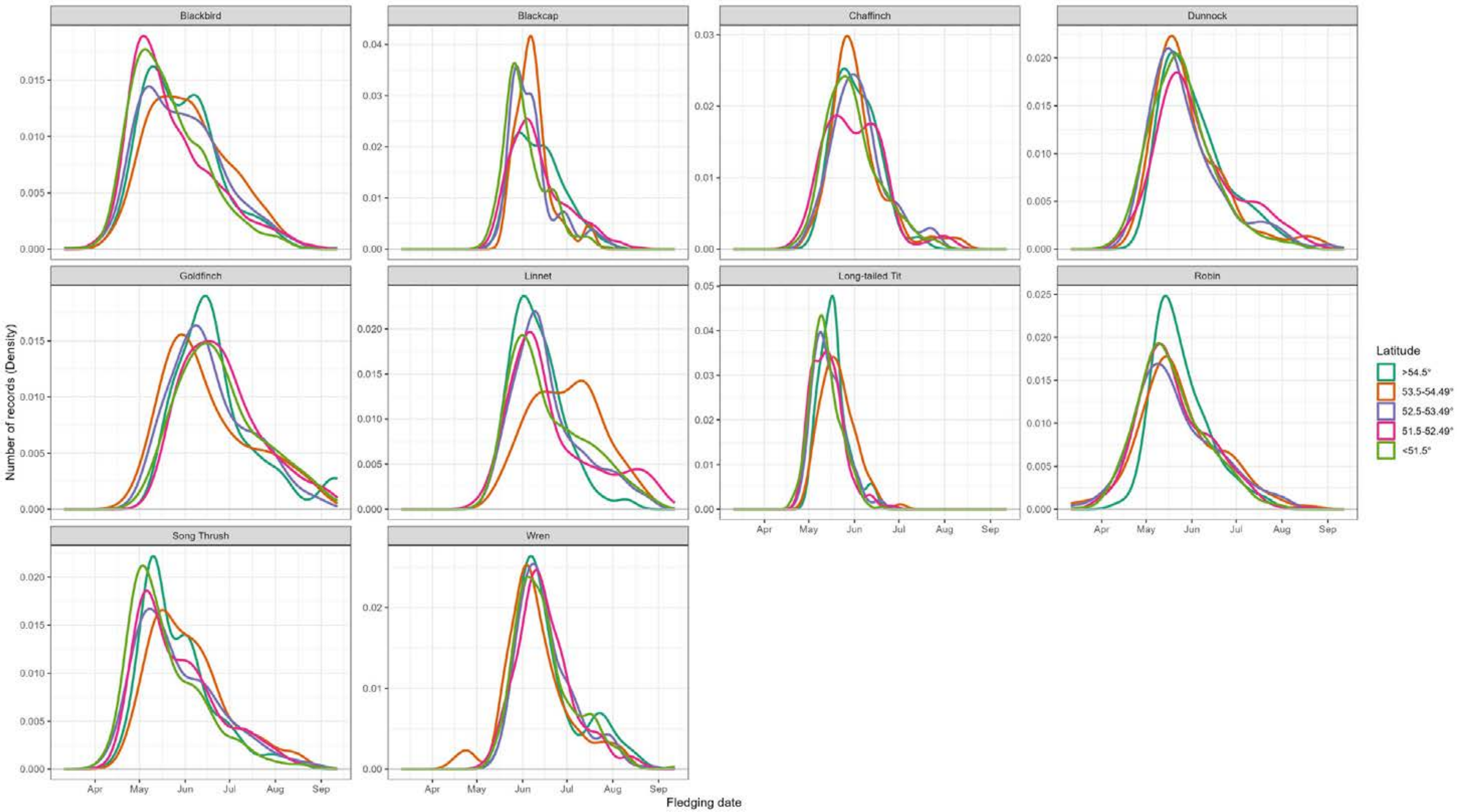
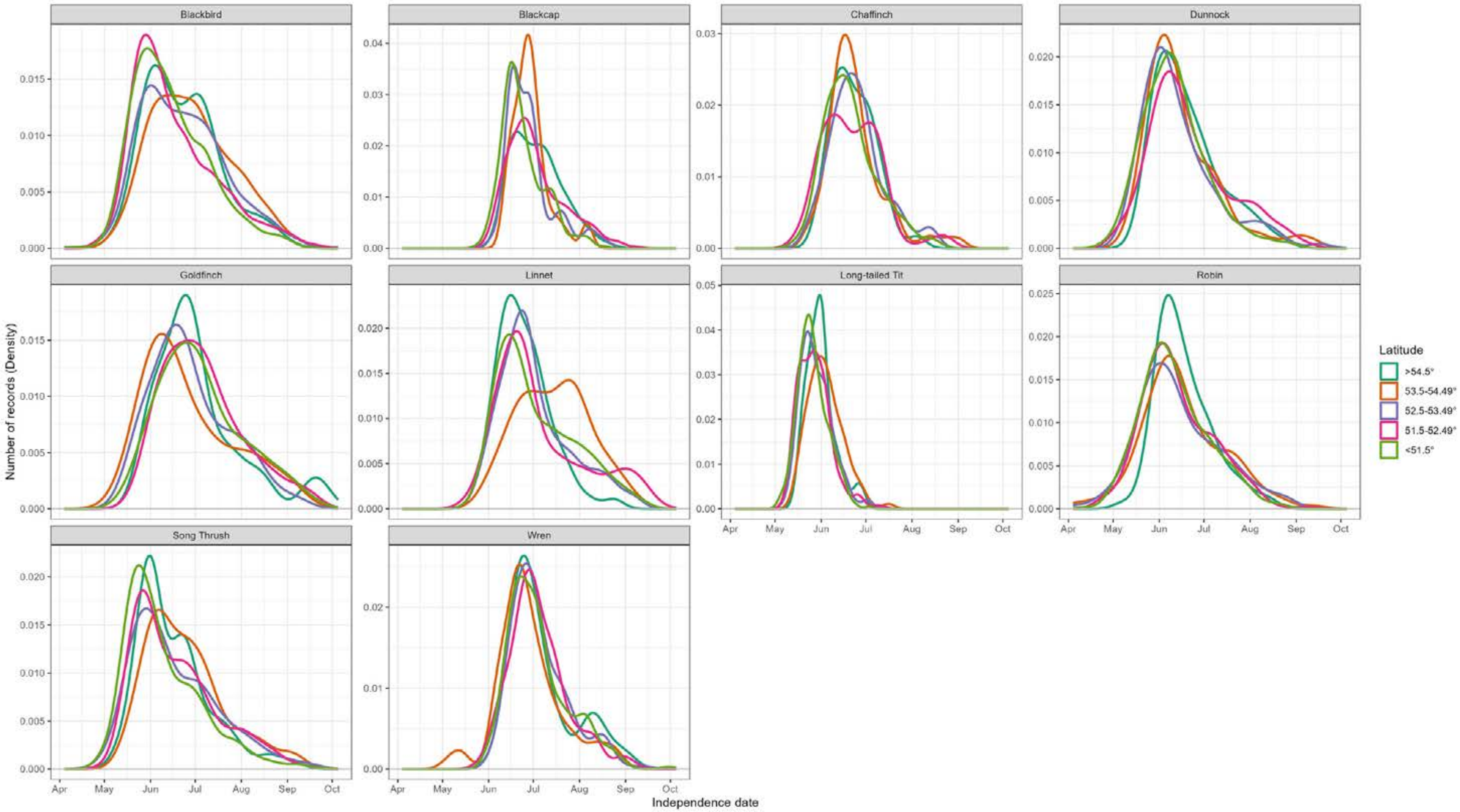


Figure A6.2. Density plot of independence dates by latitude band in England for all species for which at least 50 Nest Record Scheme records have been submitted from at least three of the five latitude bands over the study period.



Appendix 7. Nesting phenology by elevation band.

Figure A7.1. Density plot of fledging dates for sites a) below 200 m elevation, and b) equal to or over 200 m elevation, for all species for which at least 50 Nest Record Scheme records in both elevation bands over the study period in England. N=sample size.

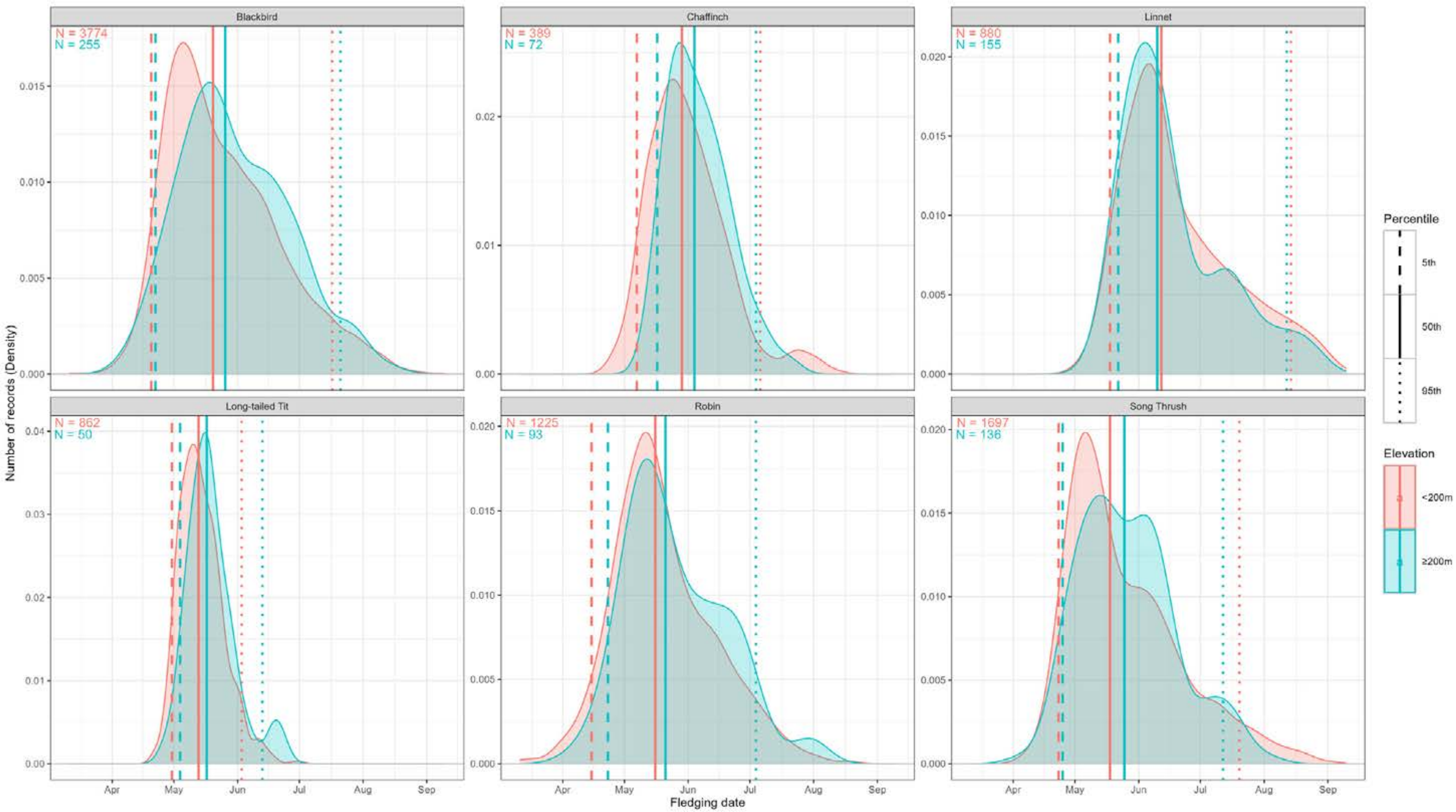
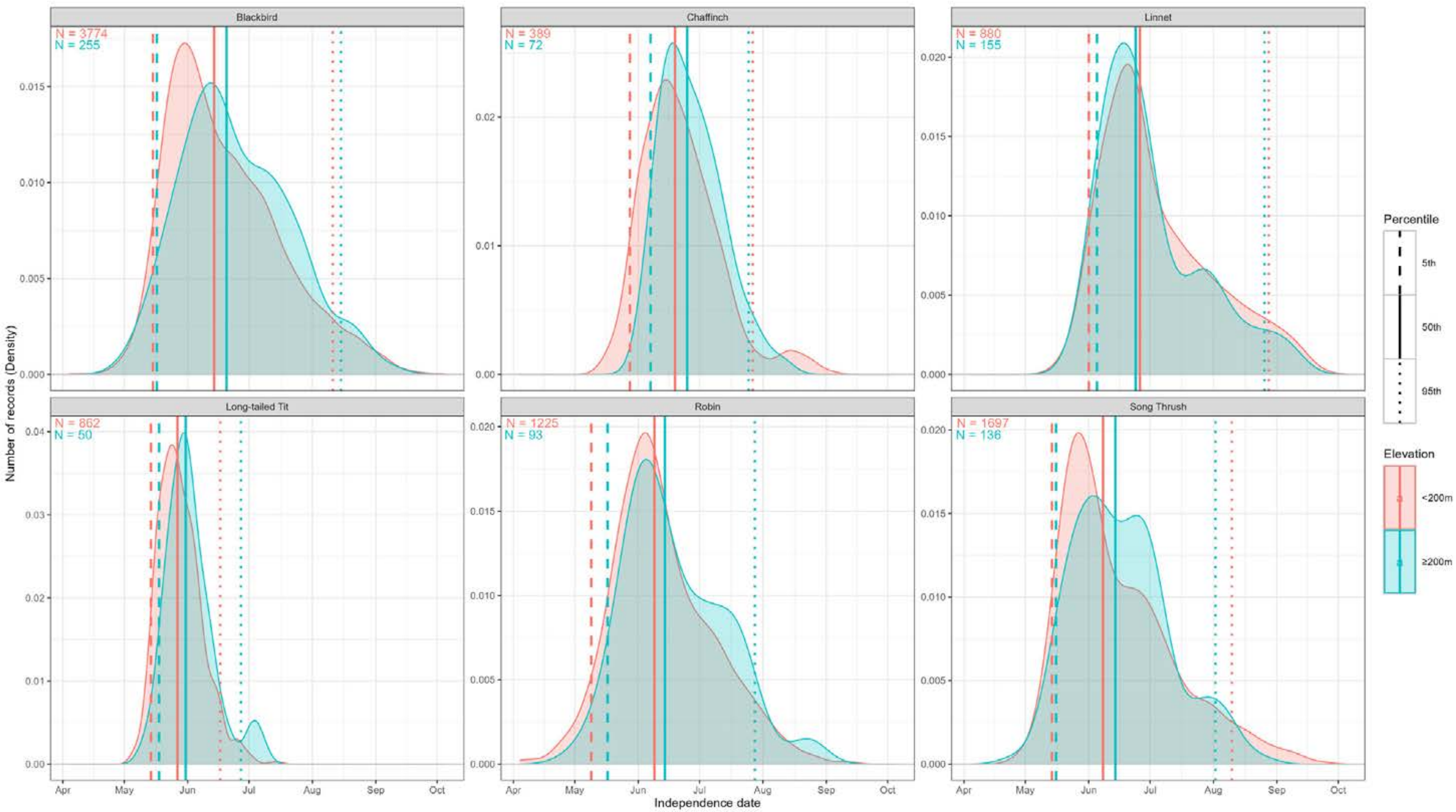


Figure A7.2. Density plot of independence dates for sites a) below 200 m elevation, and b) equal to or over 200 m elevation, for all species for which at least 50 Nest Record Scheme records in both elevation bands over the study period in England. N=sample size.



Appendix 8. Nesting phenology by local and dominant landscape habitat

Figure A8.1. Density plot of fledging dates for sites located in a) farmland, b) human sites, c) scrubland and d) woodland, as defined by the recorder using the standardised Crick coding system, for all species with at least 50 Nest Record Scheme records from farmland and scrubland sites, over the study period in England. N=sample size.

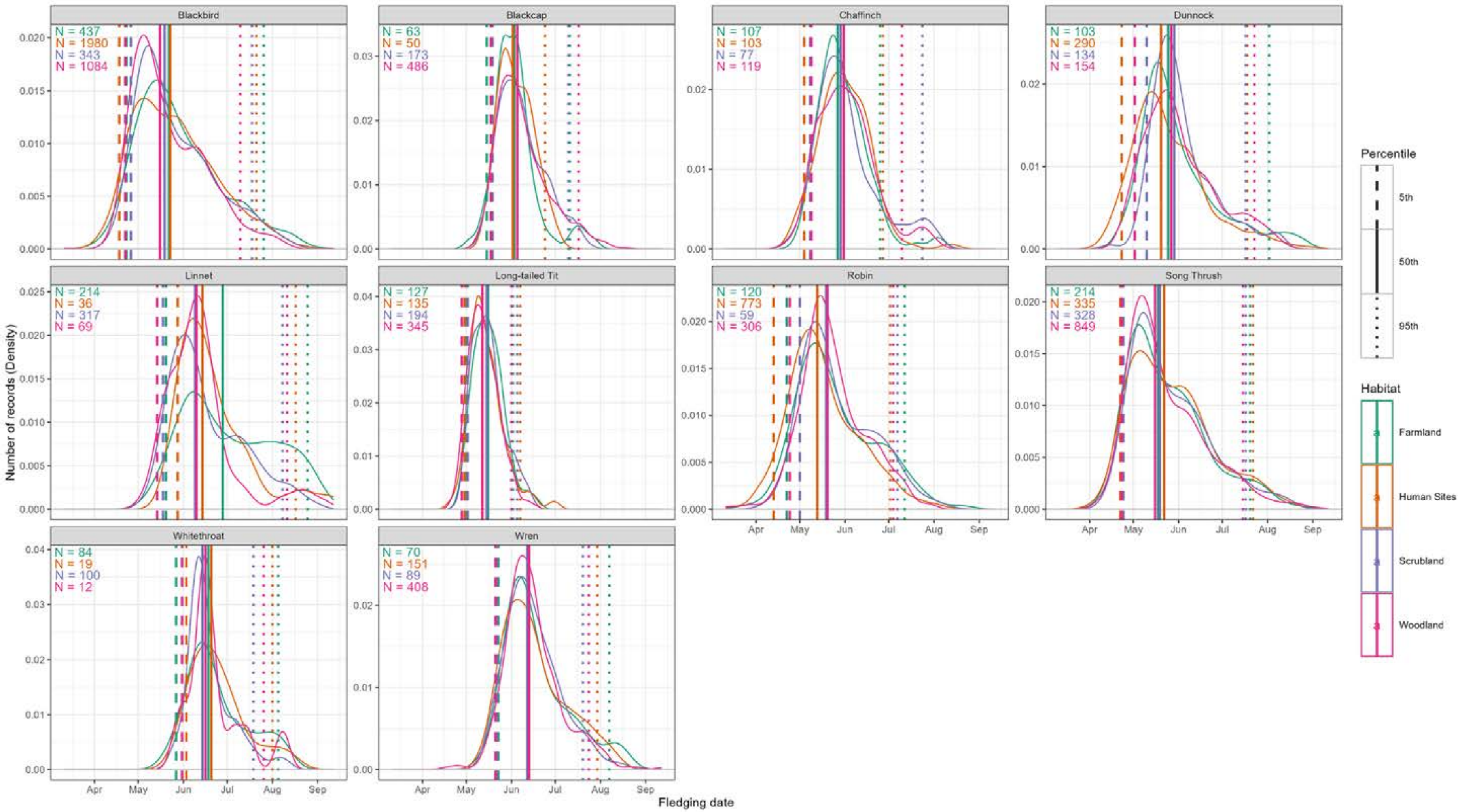


Figure A8.2. Density plot of independence dates for sites located in a) farmland, b) human sites, c) scrubland and d) woodland, as defined by the recorder using the standardised Crick coding system, for all species with at least 50 Nest Record Scheme records from farmland and scrubland sites, over the study period in England. N=sample size.

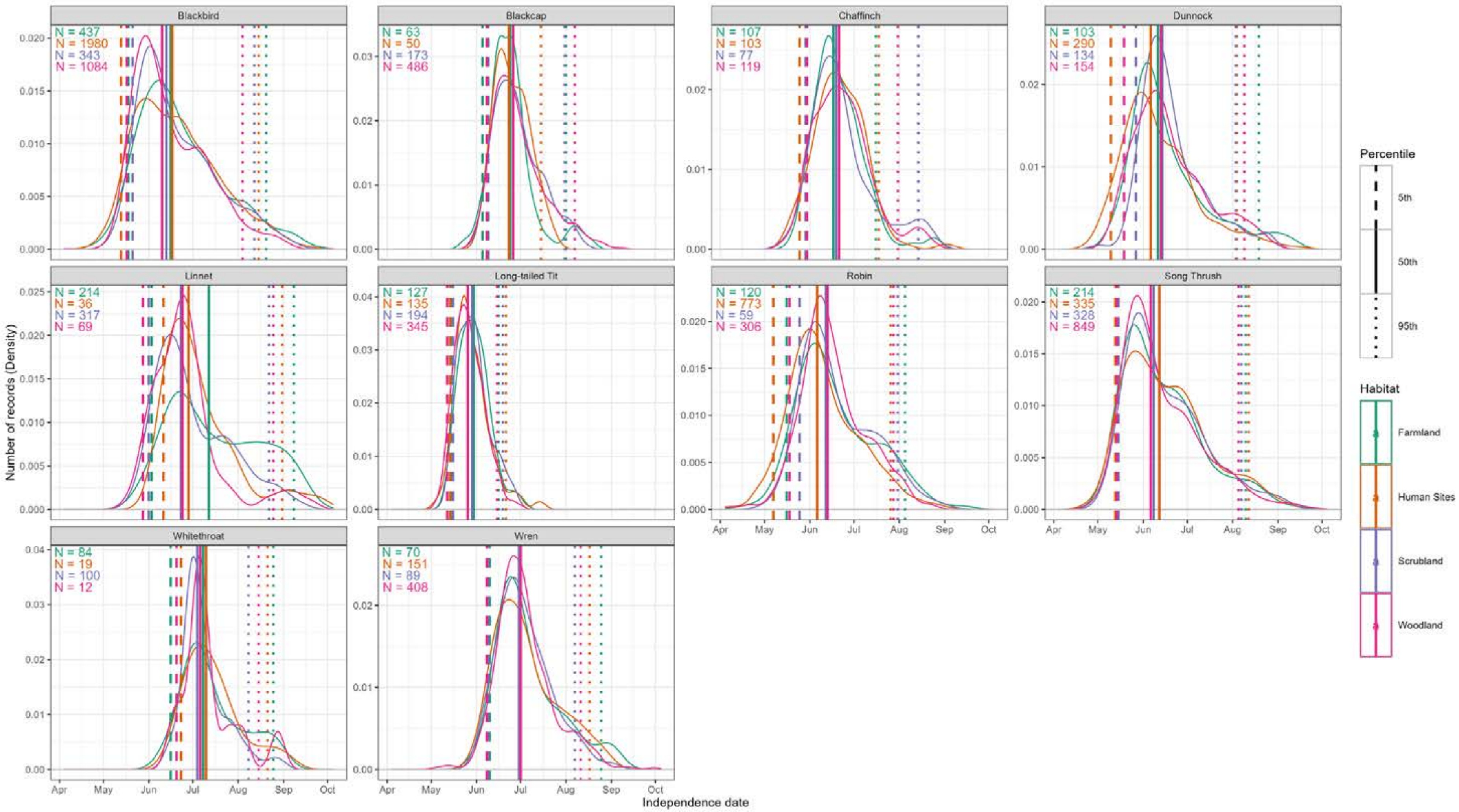


Figure A8.3. Density plot of fledging dates for landscapes (1-km Ordnance Survey squares) dominated by a) arable or b) improved grassland, as defined by Land Cover Map data (Rowland et al. 2017), for all species with at least 50 Nest Record Scheme records from both landscape categories, over the study period in England. N=sample size.

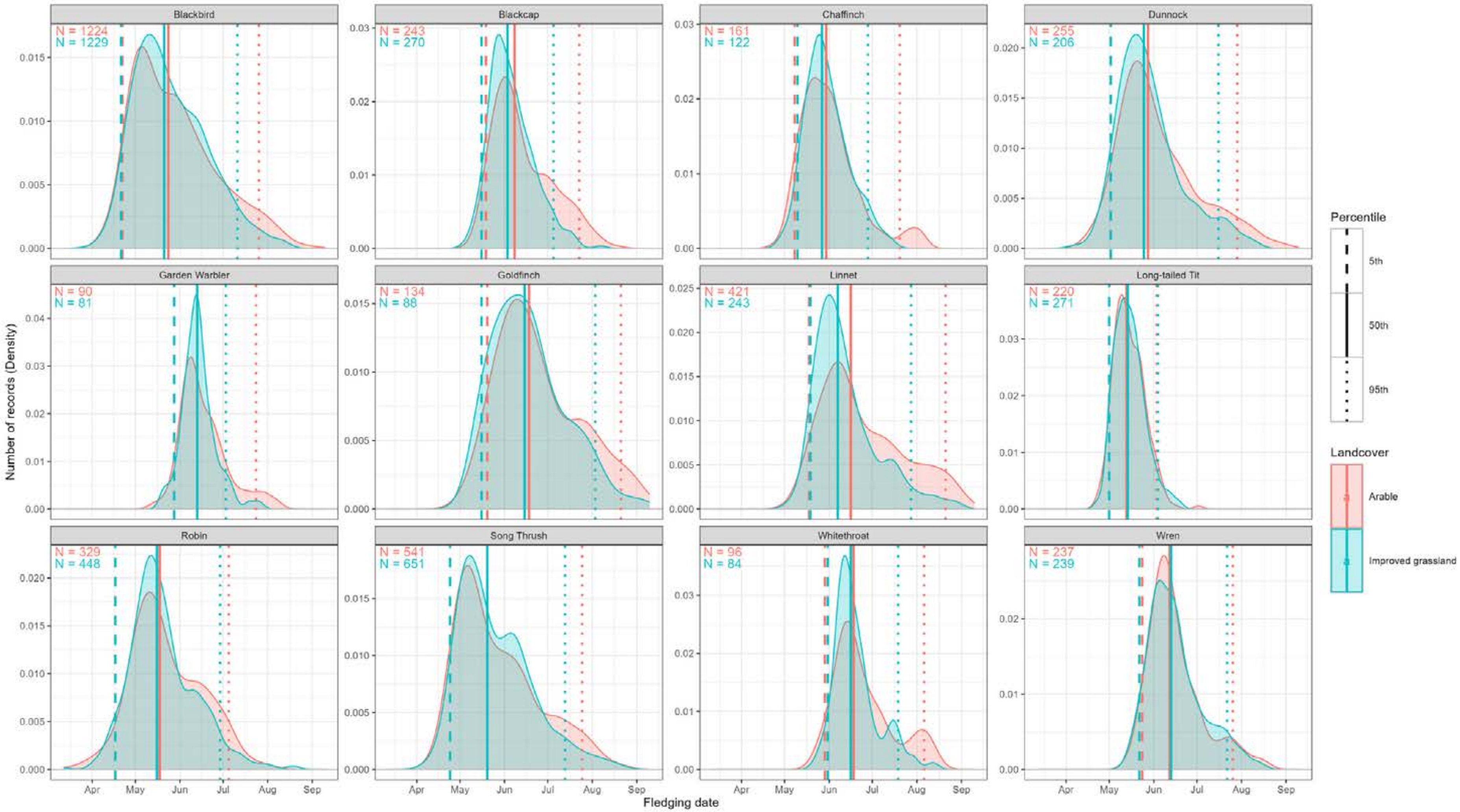
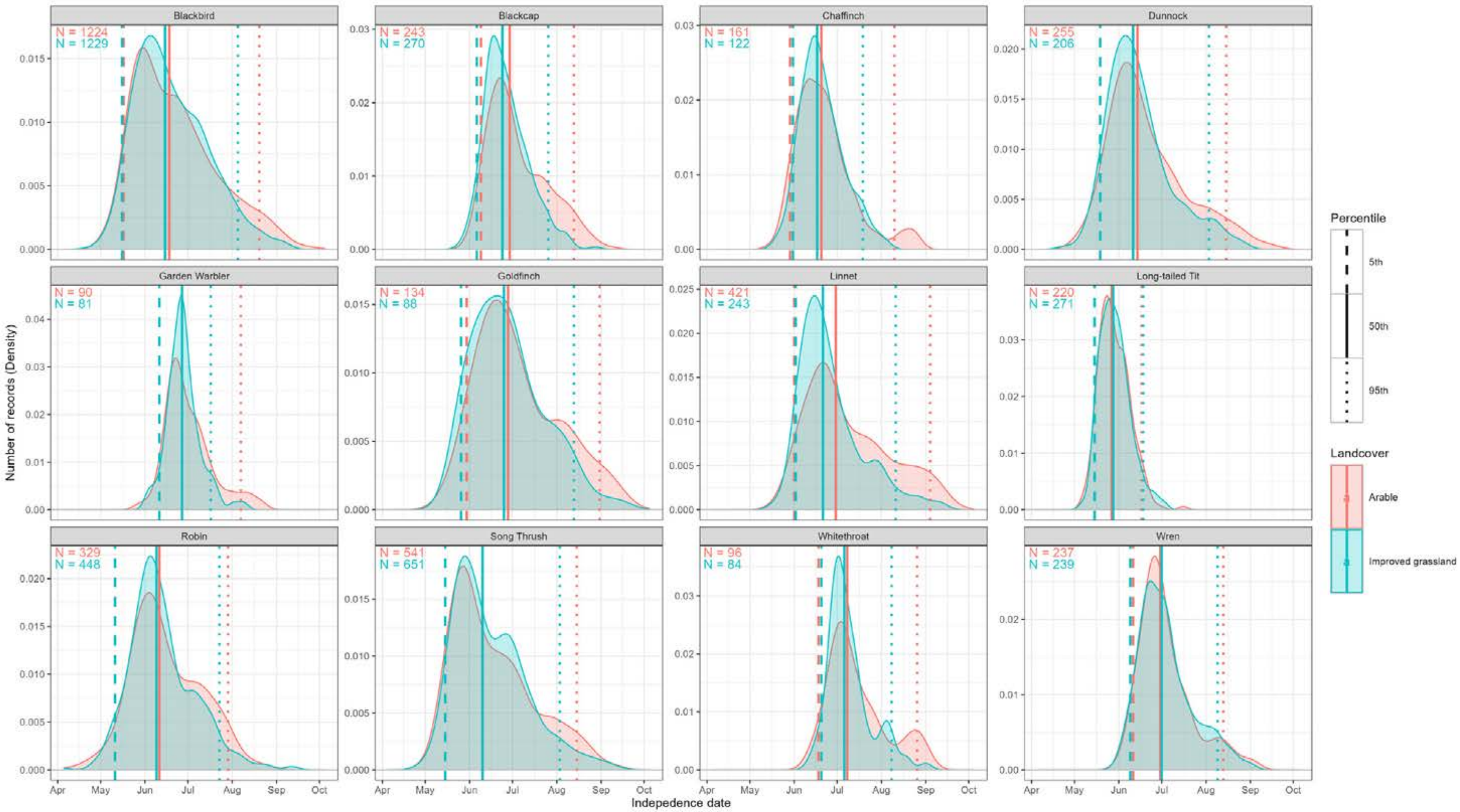


Figure A8.4. Density plot of independence dates for landscapes (1-km Ordnance Survey squares) dominated by a) arable or b) improved grassland, as defined by Land Cover Map data (Rowland et al. 2017), for all species with at least 50 Nest Record Scheme records from both landscape categories, over the study period in England. N=sample size.





Images: Yellowhammer, by Philip Croft / Chaffinch, by Tom Streeter / Bullfinch, by John Harding. Cover image: Blackbird nest, by Mike Toms

Breeding periods of hedgerow-nesting birds in England

Hedgerows form an important semi-natural habitat for birds and other wildlife in English farmland landscapes, in addition to providing other benefits to farming. They are currently maintained through annual or multi-annual cutting cycles, with management designed to occur outside the bird breeding season and the majority of related activities prohibited from 1st March to 31st August.

The aim of this analysis is to assess the impacts on nesting birds should the duration of that prohibited period be reduced, by quantifying the length of the current breeding season for 15 species of songbird likely to nest in farmland hedges (Blackbird, Blackcap, Bullfinch, Chaffinch, Dunnock, Garden Warbler, Goldfinch, Greenfinch, Linnet, Long-tailed Tit, Robin, Song Thrush, Whitethroat, Wren and Yellowhammer), including five species that contribute to the UK Farmland Bird indicator.

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