Int J Biometeorol (2008) 52:505–510
DOI 10.1007/s00484-008-0146-7

ORIGINAL PAPER

Something for the weekend? Examining the bias in avian phenological recording

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Received: 17 September 2007 / Revised: 10 December 2007 / Accepted: 10 January 2008 / Published online: 31 January 2008

Abstract In this paper we examine the bias towards weekend recording (the weekend effect) in volunteer phenology, using over 14,000 bird migration phenological observations from eight locations in the UK as a data source. Data from 45 bird species were used. Overall, 44% of all records were taken at weekends in contrast to the 28.6% (i.e. two out of seven days) that would be expected if records were evenly spread throughout the week. Whilst there is documented evidence of environmental differences at weekends, particularly in large urban areas, we believe the weekend effect is mostly a consequence of greater recorder effort at weekends. Some birds, likely to be obvious by their behaviour or abundance, had fewer weekend records than the remaining species. The weekend effect, to some extent, differed between locations and between seasons. There was some evidence that, particularly in autumn, the weekend bias may be lessening. If so, this will increase the accuracy of phenological records, making the detection of changes and responses to temperature easier.

Keywords Autumn · Detectability · Migration · Phenology · Spring

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Introduction

Phenological observations on the spring arrivals and autumn departures of birds have a fundamental role in understanding the effect of climate change on bird populations (Lehikoinen et al. 2004). However, the detection of birds is affected by the behaviour of migrants, their time of migration, population size and the detectability of the species (reviewed by Tryjanowski et al. 2005). Some of the biases are of a predictable nature, and could be included (controlled for) in statistical analyses. We predict that this will be true in the case of a weekend bias in recording of phenological (and ecological in the broad sense) studies undertaken by non-professionals. For example, the number of weekend records of rare birds or first arrival dates (Fraser 1997) is over-represented because observers' activity is greater on Saturdays and Sundays.

On the other hand, bird activity may be influenced by differences in environmental variables during weekends, compared to weekdays, in such measures as traffic, anthropogenic gases and other pollution, and, in large urban areas, even temperature and rainfall (e.g. Gordon 1994; Simmonds and Keay 1997; Cerveny and Balling 1998; Qin et al. 2004; Shutters and Balling 2006). Human disturbance can also influence weekend bird behaviour (e.g. Stalmaster and Kaiser 1998; Lafferty 2001; Bautista et al. 2004). Although, to date, some papers have included information on a weekend bias in avian phenological and other studies (Loxton et al. 1998; Ptaszyk et al. 2003), authors have not looked at this phenomenon in detail. For example, does a weekend bias have serious consequences on drawing inferences from the data? We do not know if some birds, for example those of more remote or specialised habitats, have a greater preponderance for weekend recording. We do not know if increased leisure time, for example through longer retirement and a greater number of pensioners, have increased non-weekend recording. Hence, in this paper we use an extensive data set of >14,000 observations collected by amateur ornithologists in the UK and attempt to answer the following questions:

1. What is the extent of weekend recording of bird phenology?
2. Are some bird species more associated with weekend recording and, if so, what factors may influence this?
3. Is the status of weekend recording changing over time?

Materials and methods

From eight UK “county” bird reports we obtained dates of the first spring observation of migrant birds; from four of these the last observation in autumn was also available. These are intended to represent the first spring arrivals and last autumn departures. In each report, we restricted our attention to species providing a minimum of 20 years of data. The sources of the data and the number of species examined in each are listed in Table 1. Overall, data were assembled on 45 different species in spring and 41 in autumn. In total, we obtained 225 spring series and 117 autumn series of at least 20 years duration.

Dates were converted into days of the week, and weekends separated from days during the week; henceforth called weekdays. Numbers of records for each day were summarised for each site/season and compared for each season using two-way ANOVA (factors day and site) followed by Tukey tests. For both spring and autumn, the proportion of weekend records across species in each year and at each site was calculated. This was summarised across years, and also regressed against year to look for trends. For each series, data were converted to binary variables (Monday to Friday as 0, Saturday and Sunday as 1). Using binary logistic regression, each series was regressed against year to examine for trends in weekend recording in individual series.

The proportion of weekend recording at sites with both spring and autumn data were compared between seasons using paired *t* tests on common species. Differences between species in each season were assessed using two way ANOVA (sites and species as factors) on the more common species only (those recorded at five or more sites in spring, or three or more sites in autumn). All analysis was undertaken using the MINITAB statistical package.

Results

Extent of weekend recording

There was clearly more weekend recording than would be expected (i.e. 28.6%) if recording was spread evenly throughout the week (Table 1, Fig. 1). The average of the 342 series was 44% weekend records, with 43% in the 225 spring series and 46% in the 117 autumn series. Every site/season exceeded a mean weekend recording of 39%, and that of Leicestershire was the highest at 51%. In comparing autumn and spring recording there was more weekend recording in autumn at Bristol (t_{20}=2.14, P=0.045) and Essex (t_{31}=4.29, P<0.001), but not Sheffield (t_{23}=0.08, P=0.78) or Suffolk (t_{39}=0.08, P=0.94). For both spring and autumn records, Tukey tests revealed that both Saturday and Sunday had significantly more records than each weekday, none of which were significantly different from one another. In addition, autumn Sundays had significantly more records than autumn Saturdays (P=0.036) (Fig. 1).

Differences between species

We focus on the 24 spring species recorded at 5+ sites and 23 autumn species recorded at 3+ sites. Despite the

Table 1 The source and duration of the 225 spring and 117 autumn series of data, the overall proportion of records recorded at weekends (*%WE*) and a summary of a regression of the percentage of weekend records on year; slope (*b*), standard error of slope (*SE*) and significance of slope (*P*)

		First spring record					Last autumn record				
		Nspp	%WE	b	SE	*P*	Nspp	%WE	B	SE	*P*
Wharfedale	1947–2002	14	39	−0.39	0.14	0.008					
Bristol	1947–2002	23	43	−0.06	0.11	0.62	21	49	−0.20	0.11	0.069
Essex	1950–2002	32	43	0.09	0.08	0.26	32	53	−0.29	0.11	0.011
Sussex	1960–2002	38	43	−0.16	0.12	0.19					
Sheffield	1973–2002	24	46	−0.24	0.20	0.25	24	46	−0.61	0.24	0.018
Leics	1954–2002	23	51	−0.11	0.14	0.43					
Suffolk	1950–2004	40	39	0.05	0.08	0.50	40	40	−0.16	0.09	0.088
Barnsley	1970–2001	31	42	−0.56	0.18	0.004					

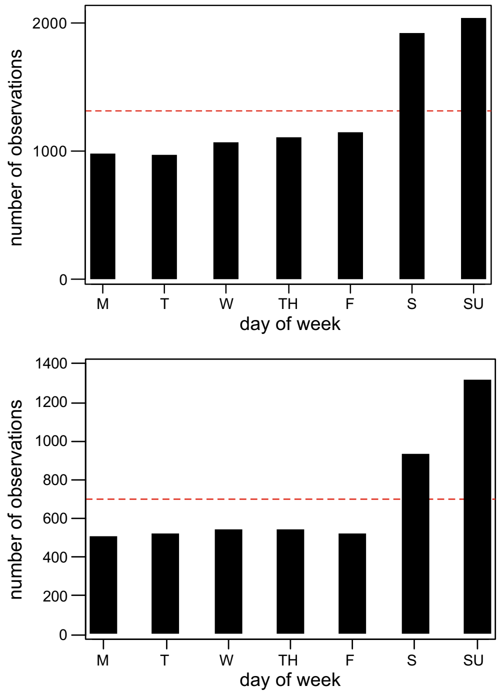

Fig. 1 The total number of observations on each day of the week for first spring records (*upper*) and last autumn records (*lower*). The *horizontal reference line* indicates the level (28.6%) that would be expected if observations were evenly spread through the week

apparent large differences between species in the weekend recording element there were no significant differences between species in a two-way ANOVA ($F_{23,142}$=1.14 P=0.31 spring, $F_{22,64}$=1.06 P=0.41 autumn) although site differences were apparent ($F_{7,142}$=3.65 P=0.001 spring, $F_{3,64}$=9.67 P<0.001 autumn) (Table 2).

The results in Table 2 suggested some differences in weekend effect in different types of bird, and we wondered if this was influenced by detectability. Consequently, we formed two groups of species (similar to Tryjanowski et al. 2005); the first, a group of nine that have a familiar song (Cuckoo *Cuculus canorus*, Grasshopper Warbler *Locustella naevia*, Nightingale *Luscinia megarhynchos*, Turtle Dove *Streptopelia tutur*), fly in groups (House Martin *Delichon urbica*, Sand Martin *Riparia riparia*, Swallow *Hirundo rustica*, Swift *Apus apus*), or which have a population over 1 million pairs (Willow Warbler *Phyllocopus trochilus*) according to figures from the British Trust for Ornithology (http://www.bto.org.uk), all of which may encourage more regular recording; and the second, the remaining 15 species. The "familiar" group had significantly less spring weekend records (41.4%±1.13) than the "remaining" group (44.7% ± 0.73; two-sample t test: t_{22}=2.60, P=0.017). For an autumn comparison, it did not seem appropriate to include the

Table 2 The 24 bird species recorded in spring at five or more sites and the 23 species recorded in autumn at three or more sites arranged in increasing order of the mean percentage of records taken at weekends (*%WE*)

Spring			Autumn		
Species	Nsites	Mean %WE	Species	Nsites	Mean %WE
Cuckoo *Cuculus canorus*	8	35.6	Little Ringed Plover	3	38.1
Grasshopper Warbler *Locustella naevia*	7	36.8	Lesser Whitethroat	4	41.2
House Martin *Delichon urbica*	8	39.4	Turtle Dove	4	41.3
Whinchat *Saxicola rubetra*	7	39.5	Spotted Flycatcher	4	41.4
Spotted Flycatcher *Muscicapa striata*	8	40.7	Swift	4	41.5
Willow Warbler *Phylloscopus trochilus*	8	41.1	Pied Flycatcher	4	41.8
Little Ringed Plover *Charadrius dubius*	5	43.0	Tree Pipit	4	42.4
Redstart *Phoenicurus phoenicurus*	8	43.4	Swallow	4	43.0
Lesser Whitethroat *Sylvia curruca*	7	43.4	House Martin	4	43.2
Nightingale *Luscinia megarhynchos*	5	43.6	Whitethroat	4	44.3
Yellow Wagtail *Motacilla flava*	8	43.7	Sedge Warbler	4	44.8
Sand Martin *Riparia riparia*	8	43.7	Wood Warbler	3	45.3
Swallow *Hirundo rustica*	8	43.8	Garden Warbler	4	47.3
Turtle Dove *Streptopelia turtur*	7	43.9	Cuckoo	4	47.8
Wood Warbler *Phylloscopus sibilatrix*	8	44.0	Grasshopper Warbler	4	48.4
Pied Flycatcher *Ficedula hypoleuca*	7	44.2	Redstart	4	48.6
Wheatear *Oenanthe oenanthe*	7	44.2	Sand Martin	4	48.8
Swift *Apus apus*	8	44.6	Wheatear	4	50.3
Tree Pipit *Anthus trivalis*	7	45.5	Yellow Wagtail	4	52.9
Whitethroat *Sylvia communis*	7	46.6	Ring Ouzel	4	53.1
Reed Warbler *Acrocephalus scirpaceus*	7	46.9	Whinchat	4	53.6
Sedge Warbler *Acrocephalus schoenobaenus*	7	47.3	Willow Warbler	4	54.1
Ring Ouzel *Turdus torquatus*	6	47.8	Reed Warbler	4	54.7
Garden Warbler *Sylvia borin*	7	50.6			

"song" group in the first category, so they were transferred to the remaining group. There were no significant differences between these two autumn groups (46.1%±2.35 vs 46.5%± 1.18; two-sample *t* test: t_{21}=0.15, *P*=0.88).

Trends over time

Analysis of mean weekend sightings against year at each site/season suggested significant reductions in weekend recording at Wharfedale and Barnsley in spring and Essex and Sheffield in autumn (Table 1, Fig. 2). Furthermore, marginally significant reductions were evident for the other two autumn sites. The mean Essex autumn trend was significantly greater than its spring trend (t_{31}=−2.17 *P*= 0.038), that for Suffolk marginally significant (t_{39}=−1.87, *P*=0.069), while Bristol (t_{20}=0.29 *P*=0.77) and Sheffield (t_{23}=1.11 *P*=0.28) were not significantly different.

For individual series, binary logistic regression revealed similar levels of significance to those that might be expected by chance; 11 significantly negative trends and 1 significantly positive out of 225 spring series, and 7 significantly negative and none significantly positive out of 117 autumn series. There was a slight bias to negative trends; 126 (56%) negative in spring and 75 (64%) negative in autumn. With the following exceptions, site/seasons produced none or only a single significance; Wharfedale spring, two significantly negative, Barnsley spring, three significantly negative, Essex autumn, four significantly negative; Sheffield autumn, two significantly negative. Of the species, only two had more than one significant response; these were Chiffchaff (*Phylloscopus collybita*) with two significantly negative in spring (out of only four) and Spotted Flycatcher (*Muscicapa striata*) with two significantly negative in spring and one significantly negative in autumn.

In examining differences in trends in weekend recording between species, we focussed on the 24 spring species and 23 autumn species as mentioned above. As for the analysis of the level of weekend recording, there were no significant differences in trends between species ($F_{23,142}$=1.18 *P*=0.27 spring, $F_{22,64}$=0.93 *P*=0.56 autumn), although site differences were again apparent ($F_{7,142}$=2.44 *P*=0.022 spring, $F_{3,64}$=2.83 *P*=0.045 autumn) (Table 3). There was no consistent correlation between mean spring and mean autumn trends for species (Pearson r_{21}=−0.026, *P*=0.90).

The "familiar" group had a smaller but not significantly smaller mean trend in spring weekend records (−0.0010± 0.0022) than the "remaining" group (−0.0096±0.0037; two-sample *t* test: t_{22}=−1.68, *P*=0.107). For the modified autumn groups there was also no significant difference (−0.0129±0.0082 vs −0.0156±0.0033; two-sample *t* test: t_{21}=−0.33, *P*=0.74).

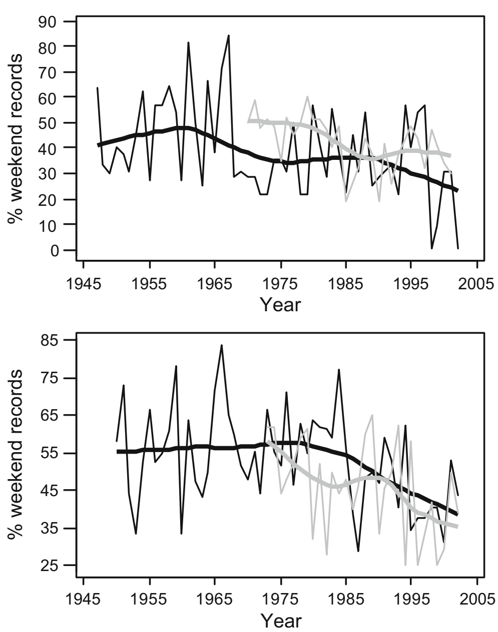

Fig. 2 Changes in weekend effect in spring records (*upper graph*, *black lines* Wharfedale, *grey lines* Barnsley) and autumn records (*lower graph*, *black lines* Essex, *grey lines* Sheffield). The *thicker* lines reveal the underlying pattern as suggested by a LOWESS (locally weighted scatterplot smoother) line

Discussion

In the analysed data, there was a greater bias towards weekend recording than would be expected from a uniformity of observations across the week. The situation may also be complicated by the fact that some environmental conditions are different during weekends, and can differ between urban and rural areas (Bautista et al. 2004), making it difficult to say which will most affect bird populations. In our data, the more urban areas (e.g. Sheffield, Barnsley) do not appear to be substantially different in weekend bias than the predominantly rural ones. We believe that for the majority of our species the bias to weekend recording is related to observer activity (see also Fraser 1997; Loxton et al. 1998; Ptaszyk et al. 2003; Surmacki 2005). In some locations, there may not be a simple relationship between species in their detectability during the weekend, because some bird species can be affected by hunters, who also have a greater activity during weekends (Bautista et al. 2004), or by other human disturbance (Stalmaster and Kaiser 1998; Lafferty 2001), although the former is probably not a major consideration in the UK where hunting levels are low.

Table 3 The 24 bird species recorded in spring at five or more sites and the 23 species recorded in autumn at three or more sites arranged in increasing order of the mean trend in weekend recording

Spring			Autumn		
Species	Nsites	Mean trend	Species	Nsites	Mean trend
Spotted Flycatcher	8	−0.0364	Reed Warbler	4	−0.0376
Ring Ouzel	6	−0.0280	Turtle Dove	4	−0.0339
Reed Warbler	7	−0.0218	Little Ringed Plover	3	−0.0321
Wheatear	7	−0.0190	Ring Ouzel	4	−0.0316
Tree Pipit	7	−0.0175	Willow Warbler	4	−0.0309
Whitethroat	7	−0.0172	Whitethroat	4	−0.0294
Sedge Warbler	7	−0.0160	Cuckoo	4	−0.0281
Redstart	8	−0.0136	Pied Flycatcher	4	−0.0277
Swallow	8	−0.0087	Sand Martin	4	−0.0269
Swift	8	−0.0068	Redstart	4	−0.0180
Nightingale	5	−0.0044	Lesser Whitethroat	4	−0.0179
Willow Warbler	8	−0.0042	Sedge Warbler	4	−0.0142
Wood Warbler	8	−0.0040	Spotted Flycatcher	4	−0.0120
Cuckoo	8	−0.0036	Whinchat	4	−0.0116
Yellow Wagtail	8	−0.0011	Swift	4	−0.0114
Grasshopper Warbler	7	−0.0009	House Martin	4	−0.0111
Pied Flycatcher	7	0.0013	Wheatear	4	−0.0102
Sand Martin	8	0.0015	Yellow Wagtail	4	−0.0039
Lesser Whitethroat	7	0.0019	Grasshopper Warbler	4	0.0010
Garden Warbler	7	0.0041	Garden Warbler	4	0.0021
House Martin	8	0.0066	Tree Pipit	4	0.0110
Whinchat	7	0.0083	Wood Warbler	3	0.0130
Turtle Dove	7	0.0113	Swallow	4	0.0160
Little Ringed Plover	5	0.0144			

Interestingly, the weekend effect appears stronger in autumn than spring for two out of four sites where records from both seasons exist. This may be associated with a different detectability pattern in autumn related both to bird and observer activities. In spring, at least some species are singing and behaving territorially and are therefore quite easy to detect, even during very occasional observation. This is supported by the lower weekend effect in our group of the nine “familiar” species. In autumn, when bird behaviour is more secretive, birds are more difficult to observe and birdwatchers need to spend more time to find them, such as during weekends and/or public holidays (e.g. Surmacki 2005). The analysed species appear to show different levels of weekend bias, but we were unable to identify statistically consistent differences between individual species. Generally, birds with easy detectability (e.g. detected by characteristic song, flying in groups, super-abundant) have a lower weekend bias. Such species are those which are widely recognisable and with a long history of phenological recording such as Swallow and House Martin, or, in Central Europe, Skylark *Alauda arvensis* and White Stork *Ciconia ciconia* (Tryjanowski et al. 2005). As a consequence, it is likely that they are recorded more frequently and with greater accuracy than others, making them more suitable subjects for long-term investigation using past records. This also applies to other taxa, e.g. plants, recorded by volunteers.

Indeed, in some situations, and for very well known charismatic species, like the White Stork in Poland, a weekend bias was not even detected (Ptaszyk et al. 2003), but the weekend effect is quite common for many rarities and other birds difficult to detect (Fraser 1997; Surmacki 2005). This is another example of the ecology of a species having a strong effect on the level of the weekend effect.

The analysed data also suggest some reduced trends in weekend bias over time. This is important because increased accuracy in recording phenology will reduce noise in future analyses, for example explaining how climate change affects bird populations. It has been notoriously difficult to draw conclusions based on changes in autumn departure dates (Lehikoinen et al. 2004), so improvements to accuracy, particularly in autumn, will be welcome.

Acknowledgements We are indebted to all those people whose observations are summarised here, and to Chris Mason (Leicestershire), John Flood (Wharfedale), Dave Pearce (Barnsley), Richard Bland (Bristol), John Newnham (Sussex) and Phil Croxton (Suffolk) for making most or all of the relevant data available in electronic format.

We thank two anonymous referees for their comments on an earlier version of this manuscript.

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