

# Can bird abundance declines be detected by citizen science programmes?: A case study using Common Cuckoo *Cuculus canorus*

Sparks, T, Atkinson, S, Lewthwaite, K, Dhap, R, Moran, NJ & Tryjanowski, P

**Author post-print (accepted) deposited by Coventry University's Repository**

**Original citation & hyperlink:**

Sparks, T, Atkinson, S, Lewthwaite, K, Dhap, R, Moran, NJ & Tryjanowski, P 2017, 'Can bird abundance declines be detected by citizen science programmes?: A case study using Common Cuckoo *Cuculus canorus*' *Avian Biology Research*, vol 10. Issue 4, pp. 241-245

<http://dx.doi.org/10.3184/175815617X15036738758862>

ISSN 1758-1567

ESSN 1758-1559

Publisher: Science Reviews 2000

**Copyright © and Moral Rights are retained by the author(s) and/ or other copyright owners. A copy can be downloaded for personal non-commercial research or study, without prior permission or charge. This item cannot be reproduced or quoted extensively from without first obtaining permission in writing from the copyright holder(s). The content must not be changed in any way or sold commercially in any format or medium without the formal permission of the copyright holders.**

**This document is the author's post-print version, incorporating any revisions agreed during the peer-review process. Some differences between the published version and this version may remain and you are advised to consult the published version if you wish to cite from it.**



1 Can bird abundance ~~Cuckoo *Cuculus canorus*~~ declines be confirmed  
2 detected by ~~two independent UK~~ citizen science programmes? A case study  
3 using Common Cuckoo *Cuculus canorus*  
4

5 Suggested running title: Citizen science and Cuckoo decline  
6

7 T.H. Sparks<sup>1,2,\*</sup>, S. Atkinson<sup>3</sup>, K. Lewthwaite<sup>3</sup>, R.Dhap<sup>2</sup>, N.J. Moran<sup>4</sup> and P. Tryjanowski<sup>1</sup>

8 <sup>1</sup>Institute of Zoology, Poznań University of Life Sciences, Wojska Polskiego 71C, 60-625  
9 Poznań, Poland

10 <sup>2</sup>Coventry University, Priory Street, Coventry CV1 5FB, UK

11 <sup>3</sup>The Woodland Trust, Kempton Way, Grantham, Lincolnshire NG31 6LL, UK

12 <sup>4</sup>British Trust for Ornithology, The Nunnery, Thetford, Norfolk IP24 2PU, UK  
13

14 \*Author for correspondence: Faculty of Engineering, Environment and Computing, Coventry  
15 University, Priory Street, Coventry CV1 5FB, UK . E-mail: ab1638@coventry.ac.uk  
16

17 No of words: ~~2100~~ 2300 approx

18 No of Figures: ~~2~~ 1(+1?)

19 No of Tables: 1  
20

21 **Abstract**

22 Using data from two independent UK citizen science schemes we investigate evidence for

23 declines in abundance of Common Cuckoo *Cuculus canorus*, a species that is particularly

24 easy to record. One of the schemes (Nature's Calendar) involves phenological recording

25 across various taxa and is open to the general public, the other (BirdTrack) targets more

26 committed birdwatchers. Results show a very strong correlation between the two schemes

27 and confirm their ability to detect a-the marked decline in the abundance of Common Cuckoo

28 in the UK in the 21<sup>st</sup> century. Furthermore, the first scheme allows some tentative

regional 29 comparisons with data from a century earlier, and suggests regional differences in

Common 30 Cuckoo decline over the longer term.

31

32 Key words: BirdTrack, Nature's Calendar, phenology, population decline, Barn Swallow

## 33 1.Introduction

34 Recently, farmland birds, especially long-distance migrants, have experienced serious  
35 declines across Europe, including in the UK. Although the process-pattern is well  
36 documented (Newton, 2004), there is not a close link between information on  
population  
37 declines and political action, to change farming practices (Hall, 2004). To facilitate  
political  
38 action a better understanding by the general public of the processes driving population  
39 decline is necessary. One common practice to increase awareness is to ask non-professionals  
40 to collect data on particular species; one of the best examples of what is now known as  
41 citizen science (Dickinson *et al.*, 2010). Citizen science can be broadly split into those  
42 schemes in which anyone can take part and those which require technical and/or species  
43 identification skills (e.g. Newson *et al.*, 2016). In the former, using untrained observers, it is  
44 safer to use data on easily identified and detectable species (Dickinson *et al.*, 2010). For these  
45 very reasons, we believe that the Common Cuckoo *Cuculus canorus*, hereafter Cuckoo, is  
46 potentially a very good candidate to study. This species is characterized by a high rate of  
47 detectability during the breeding season (characteristic, loud vocalization or song, which  
48 favours surveys), it arrives late in the breeding season and hence can be compared to the 49  
distribution and abundance of other species that have already started to reproduce (Saino *et*  
50 *al.*, 2009; Douglas *et al.*, 2010; Jiguet *et al.*, 2012; Tryjanowski and Morelli, 2015).

51 Moreover, the Cuckoo is an iconic bird of spring in the UK and in many other  
52 countries. Its brood-parasitic nature has earned it a place in mythology and its  
intricate  
53 behaviour is still being unravelled (Davies, 2011). It is more often detected by its  
classic call

54 than by sight. Urban myth has it that the earliest detection in spring was traditionally  
reported

55 in the Letters Page of the *London Times* but ~~a-our~~ search of the digitised version of  
that

56 newspaper ~~would~~ produced limited evidence in support of this claim (see also  
Rusbridge,

57 2008). There are, however, first arrival records from the Marsham family in Norfolk  
dating 58 back to 1739 (Sparks and Carey, 1995) and some earlier individual  
records for the UK.

59 Recently the decline of this species in the UK has been very marked (Douglas *et al.*,  
60 2010). Harris *et al.* (2015) reported its UK decline to be 46% in the 1995–2013  
period. Over

61 a longer period, 1967–2012, the decline across England was estimated as 76% (Baillie  
*et al.*,

62 2014). The decline in Cuckoo is much less apparent in Europe as a whole with the  
1980– 63 2012 decline estimated at 26%, but only at 6% in the recent decade  
(2003–2012, PECMBS

64 2014). Thus the recent change in the UK, where the species has now been red-listed  
(Eaton et

65 al., 2009), appears to be more serious than at the continent-scale. Because of the  
large range

66 of the adult birds and the brood-parasitic nature of their life cycle it is difficult to  
obtain

67 estimates of population size and even more so of reproductive performance. The  
causes of the

68 decline are equivocal, but could include deterioration of conditions on overwintering  
grounds

69 and along migration routes, reduced host availability, climate change causing  
asynchrony

70 with host species, and reduced prey (e.g., Conrad et al., 2004; Douglas et al., 2010;

Hewson 71 et al., 2016)

72 In this paper we examine data from two independent UK citizen science schemes to  
73 assess whether these can generate surrogates of population change. Since recorder  
effort can

74 ~~vary non-monotonically~~ fluctuate from year-to-year we have used records of Barn  
Swallow

75 Hirundo rustica, hereafter Swallow, as a “control”. The Swallow is another iconic  
species of

76 spring and is a very numerous, obvious species; even occasionally acting as a host for

77 Cuckoo (Liang et al., 2014). The use of Swallow as a control was determined by the  
choice

78 of species recorded in Nature’s Calendar, both currently and in the historical record,  
where it

79 is by far one of the most popular species. Given that most bird-active recorders will  
record

80 Swallow, use of this species as a control will allow estimation of the commonness of  
Cuckoo

81 records. We have created a very simple index for Cuckoos, being the number of Cuckoo



81 records as a percentage of the number of Swallow records, and have examined this for  
82 evidence of change in the 21<sup>st</sup> century and in comparison to records from 70–120 years ago.

83

## 84 **2. Materials and Methods**

### 85 *2.1. Data sources*

86 Two citizen science programmes were used to provide data on the relative numbers of  
87 Cuckoo and Swallow records. The first of these was Nature’s Calendar  
88 ([www.naturescalendar.org.uk](http://www.naturescalendar.org.uk)), open to the general public, which collates phenological data  
89 in the UK. The scheme has been running since 1998, but was quite limited in the first year. In  
90 addition, the scheme has backloaded a large number of older records including those  
91 collected by the Royal Meteorological Society between 1891 and 1947. Data on first  
92 observations of Cuckoo (usually song) and Swallow (usually visual) were abstracted for the  
93 periods 1891–1947 and 1999–2014 at the UK level, and component regions. Data were  
94 excluded for 1932 because of incomplete records, and insufficient Northern Ireland records  
95 were available for the 1891–1947 period. Records from London and for Northern Ireland tend  
96 to be less numerous and results may need to be treated with caution. ~~For each year, f~~For the  
97 whole of the UK and for each region separately, a simple index ~~of for~~ Cuckoo ~~records~~ was  
98 calculated as the ~~percentage number~~ of Cuckoo records ~~as a percentage of relative to~~ the  
99 number of Swallow records.

100 The second scheme was the BTO/RSPB/BirdWatch Ireland/SOC/WOS BirdTrack  
101 ([www.birdtrack.net](http://www.birdtrack.net)) which has been running since 2002. This collects numbers of sightings  
102 of birds throughout the year as a by-product of general birdwatching activities and as such  
103 typically requires more commitment from its recorders. The total number of site visits per

105 year that included observations of Cuckoo and Swallow was obtained from the website for  
106 the whole of the UK. Thus the records used here are based on presence/absence rather than  
107 on abundance. An index of Cuckoo records was obtained on the same basis as that used for  
108 the Nature’s Calendar data above. Because this scheme incorporates records throughout the  
109 year rather than just first records, and because Swallows are more numerous and have a 110  
longer summer residence than Cuckoos, the index for this scheme is inevitably lower than  
111 that from Nature’s Calendar.

112 Between 2002–2006, Nature’s Calendar also asked its recorders to note down failure  
113 to hear Cuckoo as follows “If you usually hear the Cuckoo but didn’t hear it this year,  
please  
114 tick the box” (Woodland Trust, 2005). The numbers of observers recording failure to  
hear the  
115 Cuckoo were abstracted for all years for the UK. For each year and region the  
percentage of 116 all recorders (heard + non-heard) failing to hear the Cuckoo was  
calculated.

117 [A population index for Cuckoo from the Breeding Bird Survey \(Baillie \*et al.\*, 2014\)](#)  
118 [was obtained for comparison to our Cuckoo indices.](#) ~~Where recorders had volunteered  
to 119 provide their age we also examined the influence of age on hearing cuckoos.~~

## 120 2.2. Statistical Analysis

121 The indices for the two schemes were correlated for their 13 common years (2002–2014).  
122 Trends for Nature’s Calendar indices (1999–2014) and BirdTrack indices (2002–2014) were  
123 calculated by regression on year for the whole of the UK. The indices were log<sub>e</sub>-transformed  
124 prior to regression so that proportional change, rather than absolute change, was estimated  
125 from the slope coefficient. A comparison of the Nature’s Calendar indices for UK regions for

126 | 1891–1947 and 1999–2014 was made using two sample t-tests (~~un~~equal variances not  
127 | assumed). The percentage of not-heard recorders was averaged across years for each region

128 | and compared to the Nature’s Calendar Cuckoo index for the same regions for the  
common 129 years (2002–2006) using correlation. Correlation was also used to compare our  
indices with 130 the population index from the Breeding Bird Survey. All analysis and graphs  
were generated 131 | in Minitab 17.

132

### 133 | **3.Results**

134 | The Nature’s Calendar Index was highly correlated with that from BirdTrack ( $r_{11}=0.914$ ,  
135 | ~~P~~p $<0.001$ ) and with national Breeding Bird Survey results ( $r_{14}=0.723$ ,  $p=0.002$ ). Both  
indices  
136 | show a rapid decline, especially in the middle of the period (Figure 1). Trend coefficients for  
137 | both schemes were similar and highly significantly negative suggesting a decline of 4.5% per  
138 | annum (Nature’s Calendar: coefficient  $-0.0458$ ,  $p<0.001$ ; BirdTrack: coefficient  $-0.0457$ , 139  
 $p<0.003$ ). Mean indices for both schemes were highest in the South East and East of  
England, 140 | and lower northwards and westwards.

141 | The comparison with the 1891–1947 period suggested that most regions had an  
142 | approximately equal ratio (index= $-100$ ) of Cuckoo and Swallow records in the earlier  
period  
143 | (Table 1). With the exception of the South East, indices were significantly lower in  
the recent  
144 | period for all regions. ~~Once again~~The differences between the two time periods  
appeared to 145 | be greatest in the north and west.

146 ~~For the UK, t~~The percentage of Cuckoo recorders failing to hear Cuckoo averaged  
147 across 2002–2006 was 11.8%. This varied substantially between regions from 7.2%  
for  
148 Scotland to 17.6% for London (Table 1). Excluding Scotland, there was a significant  
149 correlation between % not heard and mean index ( $r_9=-0.730$ ,  $p=0.011$ ; with Scotland  
 $r_{10}=150$  0.506,  $p=0.093$ . Index based on Nature’s Calendar). ~~We were able to detect a~~  
greater failure

151 ~~to hear cuckoo among the 60+ age group (Figure 2).~~

151

## 152 4.Discussion

153 We show a serious decline in Cuckoo for the UK during the current century, which is  
154 compatible with a far more detailed study which focused on population size of Cuckoo on  
155 farmland (Sanderson *et al.*, 2006). The indices we used are based on Cuckoo records as a  
156 percentage of Swallow records, the latter acting as a control. The data submitted to the Royal  
157 Meteorological Society’s phenology scheme between 1891 and 1947 suggests that most  
158 recorders provided first records of both Cuckoo and Swallow since the indices were  
159 approximately 100, on average, in each region. The more recent scheme, Nature’s Calendar,  
160 suggests that parity is only maintained in the South East. Elsewhere, and particularly  
161 northwards and westwards, Cuckoo now appears to be less frequently recorded than Swallow.  
162 However, this may not be true of Scotland over recent decades  
163 (<http://app.bto.org/mapstore/StoreServlet?id=276>).

164 More worryingly is that the decline in Cuckoo in the current century seems to be very  
165 rapid, with both schemes indicating a very distinct loss in the mid-“noughties”. The recent  
166 relative stability of the Cuckoo in Scotland is perhaps borne out by the low percentage of  
167 people in Scotland who reported that they did not hear ~~’s low not heard Cuckoo percentage.~~  
168 ~~Our older age group of recorders experienced a higher probability of not hearing Cuckoo~~  
169 ~~despite them being the age group that was likely to have had greater first hand experience of~~  
170 ~~nature, and being taught nature study, when younger. We do not know if this reflects reduced~~  
171 ~~hearing or reduced mobility in this group.~~

172 Our approach, a comparison with a well recorded species (in this instance the  
173 Swallow), relies on the “control” species maintaining its population and distribution. The

174 Swallow is reported to be undergoing a modest population increase (Baillie *et al.*, 2014) but  
175 we do not feel this would have a major influence on our results since Swallow is already a  
176 very obvious, very numerous and well identified species. Further confidence in this simple  
177 Cuckoo index is gained from a comparison with the % not-heard records where, with the  
178 exception of Scotland noted above, high % not-heard regions were associated with low mean  
179 indices.

180 Our paper, using Cuckoo as a case study, strongly suggests that citizen science  
181 schemes have the potential to provide valuable information about species declines in the  
182 absence of more formal population monitoring. This has previously been shown for some  
183 citizen science schemes (e.g. Studds *et al.*, 2017), but not all (e.g. Kamp *et al.*, 2016). The  
184 UK is very lucky to have ~~the latter~~ formal monitoring in place for birds and some other taxa  
185 but not all taxa and not all countries are so fortunate. Humans are not very gifted at noticing  
186 change around them, particularly when change is taking place at a modest rate (e.g. Simons  
187 & Rensink, 2005), for example climate warming (e.g. Bazerman *et al.*, 1997). Thus, we  
188 believe that it is the complete loss of a species rather than a decline in their population size  
189 that ~~probably~~ makes most impression on the human brain. The phenological and  
190 birdwatching data used here suggest that many of the recorders are no longer encountering  
191 Cuckoo in spring, a situation that seems unprecedented compared to a century earlier (see  
192 Follett and Strezov, 2015).

193 To conclude, Cuckoo is a good candidate species by which ordinary members of the  
194 public can become involved in surveys to monitor species arrival and presence. A recent  
195 study in France has used TV advertisements to encourage young people to volunteer to detect  
196 the arrival of Cuckoos in their local area and submit the information to a web-based survey.  
197 This method is proving to be an efficient way of collecting high volume data, at relatively  
198 low cost (Jiguet *et al.*, 2012)

199 ([http://www.dailymotion.com/playlist/x1yf6c\\_yannaki\\_missions-printemps-](http://www.dailymotion.com/playlist/x1yf6c_yannaki_missions-printemps-)

201 2012/1#video=xpon1m). Can these types of strategy be exploited in order to find reliable  
202 surrogates of avian diversity in those countries where structured monitoring schemes are not  
203 currently in place (Morelli *et al.*, 2015; Tryjanowski and Morelli, 2015)? We believe that the  
204 citizen science results shown here, even that which only involves first records, are an  
205 excellent warning system but present a worrying picture of the status of this particular  
206 species. Widening the involvement of the general public in monitoring taxa is now easier 207  
than ever and more likely to lead to effective conservation action (Greenwood, 2005; Follett  
208 and Strezov, 2015).

209

## 210 **Acknowledgements**

211 We thank the many thousands of committed individuals who submitted data to the Nature's  
212 Calendar and BirdTrack schemes. RD received funding from the Nuffield Gold Crest Bursary  
213 Scheme. We also thank Stephen Baillie and anonymous referees for providing  
critical 214 comments to the previous on earlier versions of the manuscript.

215

## 216 **References**

217 Baillie, S.R., Marchant, J.H., Leech, D.I., Massimino, D., Sullivan, M.J.P., Eglington,  
S.M.,  
218 Barimore, C., Dadam, D., Downie, I.S., Harris, S.J., Kew, A.J., Newson, S.E., Noble,  
219 D.G., Risely, K. & Robinson, R.A. (2014) *BirdTrends 2014: trends in numbers,*  
220 *breeding success and survival for UK breeding birds. BTO Research Report 662.*



- 221 British Trust for Ornithology. <http://www.bto.org/birdtrends>
- 222 [Bazerman, M.H., Messick, D.M., Tenbrunsel, A.E. and Wade-Benzoni, K.A. \(eds\) \(1997\)](#)
- 223 [Environment, Ethics and Behavior. The New Lexington Press.](#)
- 224 Brooke, M.D.L. and Davies, N. (1987) Recent Changes in Host Usage by Cuckoos  
*Cuculus 225 canorus* in Britain. *J. Anim. Ecol.*, **56**, 873–883.
- 226 [Conrad, K.F., Woiwod, I.P., Parsons, M., Fox, R. and Warren, M.S. \(2004\) Long-](#)
- 227 [term population trends in widespread British moths. \*Journal of Insect Conservation\*,](#)
- 228 [8, 119-136.](#)
- 229 Davies, N.B. (2011) Cuckoo adaptations: trickery and tuning. *J. Zool.*, **284**, 1-14.
- 230 Dickinson, J.L., Zuckerberg, B. and Bonter, D.N. (2010) Citizen science as an  
ecological 231 research tool: challenges and benefits. *Ann. Rev. Ecol. Evol. Syst.*, **41**,  
149-172.
- 232 Douglas, D.J., Newson, S.E., Leech, D.I., Noble, D.G. and Robinson, R.A. (2010) How 233  
important are climate-induced changes in host availability for population processes in an 234  
obligate brood parasite, the European cuckoo? *Oikos*, **119**, 1834-1840.
- 235 [Eaton, M.A., Brown, A.F., Noble, D.G., Musgrove, A.J., Hearn, R., Aebischer, N.J.,](#)
- 236 [Gibbons, D.W., Evans, A. and Gregory, R.D. \(2009\) Birds of Conservation Concern 3: the 237](#)
- 238 [population status of birds in the United Kingdom, Channel Islands and the Isle of Man. \*British Birds\*, 102, 296–341.](#)

- 239 Follett, R. and Strezov, V. (2015) An Analysis of Citizen Science Based Research:  
Usage and 240 Publication Patterns. *PLoS ONE*, **10**, e0143687.
- 241 Hall, C., McVittie, A. and Moran, D. (2004) What does the public want from agriculture and  
242 the countryside? A review of evidence and methods. *J. Rur. Stud.*, **20**, 211-225.
- 243 Harris, S.J., Massimino, D., Newson, S.E., Eaton, M.A., Balmer, D.E., Noble, D.G.,  
244 Musgrove, A.J., Gillings, S., Procter, D. and Pearce-Higgins, J.W. (2015) *The*  
245 *Breeding Bird Survey 2014. BTO Research Report 673*. British Trust for Ornithology.

- 245 [Hewson, C.M., Thorup, K., Pearce-Higgins, J.W. and Atkinson, P.W. \(2016\) Population](#)  
246 [decline is linked to migration route in the Common Cuckoo. \*Nature Communications\*,](#)  
247 [7, 12296.](#)
- 248
- 249 Hurlbert, A.H. and Liang, Z. (2012) Spatiotemporal Variation in Avian Migration Phenology:  
250 Citizen Science Reveals Effects of Climate Change. *PLoS ONE*, **7**, e31662.
- 251 Jiguet, F., Devictor, V., Julliard, R. and Couvet, D. (2012) French citizens monitoring  
252 ordinary birds provide tools for conservation and ecological sciences. *Acta Oecol.*, **44**,  
253 58–66.
- 254 [Kamp, J., Oppel, S., Heldbjerg, H., Nyegaard, T. and Donald, P. F. \(2016\) Unstructured](#)  
255 [citizen science data fail to detect long-term population declines of common birds in](#)  
256 [Denmark. \*Diversity and Distributions\*, \*\*22\*\*, 1024–1035.](#)
- 257 Liang, W., Yang, C., Wang, L. and Møller, A.P. (2013) Avoiding parasitism by breeding  
258 indoors: cuckoo parasitism of hirundines and rejection of eggs. *Behav. Ecol.*  
259 *Sociobiol.*, **67**, 913-918.
- 260 Møller, A.P. (2011) When climate change affects where birds sing. *Behav. Ecol.*, **22**, 212-  
261 217.
- 262 Morelli, F., Jiguet, F., Reif, J., Plexida, S., Valli, A.S., Indykiewicz, P., Šímová, P., Tichit,  
263 M., Moretti, M. and Tryjanowski, P. (2015) Cuckoo and biodiversity: testing the  
264 correlation between species occurrence and bird species richness in Europe. *Biol.*  
265 *Conserv.*, **190**, 123-132

266 Newson, S.E., Moran, N.J., Musgrove, A.J., Pearce-Higgins, J.W., Gillings, S., Atkinson,  
267 P.W., Miller, R., Grantham, M.J. and Baillie, S.R. (2016) Long-term changes in the  
268 migration phenology of UK breeding birds detected by large-scale citizen science  
269 recording schemes. *Ibis*, **158**, 481–495.

270 Newton, I. (2004) The recent declines of farmland bird populations in Britain: an appraisal of  
271 causal factors and conservation actions. *Ibis*, **146**, 579-600.

272 PECBMS (2014) Trends of common birds in Europe, 2014 update. CSO.

273 [Rusbridge, C. \(2008\) On hearing the first cuckoo in spring.](#)  
274 [http://www.dcc.ac.uk/news/hearing-first-cuckoo-spring \[accessed 31 May 2017\].](http://www.dcc.ac.uk/news/hearing-first-cuckoo-spring)

275 Saino, N., Rubolini, D., Lehikoinen, E., Sokolov, L.V., Bonisoli-Alquat, A., Ambrosini, R.,  
276 Boncoraglio, G. and Møller, A.P. (2009) Climate change effects on migration  
277 phenology may mismatch brood parasitic cuckoos and their hosts. *Biol. Lett.*, **5**, 539–  
278 41.

279 Sanderson, F.J., Donald, P.F., Pain, D.J., Burfield, I.J. and Van Bommel, F.P. (2006)  
280 Longterm population declines in Afro-Palearctic migrant birds. *Biol. Conserv.*, **131**,  
281 93105.

282 Sparks, T.H. and Carey, P.D. (1995) The responses of species to climate over two centuries:  
283 An analysis of the Marsham phenological record, 1736-1947. *J. Ecol.*, **83**, 321-329.

284 [Simons D.J. and Rensink, R.A. \(2005\) Change blindness: past, present, and future. \*Trends in\*](#)  
285 [\*Cognitive Sciences\*, \*\*9\*\*, 16-20.](#)

286 [Studds, C.E., Kendall, B.E., Murray, N.J., Wilson, H.B., Rogers, D.I., Clemens, R.S.,](#)  
287 [Gosbell,](#)

288 [K., Hassell, C.J., Jessop, R., Melville, D.S., Milton, D.A., Minton, C.D.T., Possingham,](#)  
289 [H.P., Riegen, A.C., Straw, P., Woehler, E.J. and Fuller, R.A. \(2017\) Rapid population](#)  
290 [decline in migratory shorebirds relying on Yellow Sea tidal mudflats as stopover sites.](#)  
291 [\*Nature Communications\*, \*\*8\*\*, 14895](#)

292 Tryjanowski, P. and Morelli, F. (2015) Presence of Cuckoo reliably indicates high bird  
293 diversity:

294 A case study in a farmland area. *Ecol. Indic.*, **55**, 52–58.

295 Woodland Trust (2005) Guide to recording spring and autumn events in Nature’s Calendar.

296 Grantham, Woodland Trust.

297

297 | Figure legends

298 Figure 1. Cuckoo indices (Cuckoo records as a percentage of Swallow records) from Nature's  
299 Calendar (1999–2014; open symbols, black line, left hand axis) and BirdTrack  
300 (2002–2014; 300 solid symbols, grey line, right hand axis).

301

302 ~~Figure 2. % failure ( $\pm$ SE) to detect cuckoo in spring in three recorder age categories (n=323, 303~~  
303 ~~1615, 1491 respectively).~~

Table 1. Mean±SE Cuckoo indices and the significance of the change (p) from Nature’s Calendar (1999–2014 cf. 1891–1947) using a two sample t-test (equal variances not assumed).

The percentage of recorders reporting failure to hear cuckoos in 2002-2006 is given in the final column (see text for details).

	1891–1947	1999–2014	t-test	<u>% not heard</u>
	Mean±SE	Mean±SE	p	
UK	101±0.6	67±4.4	<0.001	<u>11.8</u>
South West	103±1.1	53±4.5	<0.001	<u>15.2</u>
South East	105±1.2	107±4.7	0.507	<u>10.5</u>
London	117±6.6	70±16.5	0.003	<u>17.6</u>
Wales	96±1.0	53±3.3	<0.001	<u>14.9</u>
West Midlands	110±3.0	73±5.4	<0.001	<u>11.4</u>
East Midlands	105±2.3	71±5.8	<0.001	<u>10.6</u>
East of England	103±1.0	93±5.0	0.002	<u>8.1</u>
North West	101±1.8	34±4.0	<0.001	<u>17.1</u>
Yorkshire & Humberside	95±2.3	59±5.8	<0.001	<u>13.5</u>
North East	98±2.7	39±3.8	<0.001	<u>15.3</u>
Northern Ireland	Insufficient data	42±3.2		<u>13.7</u>
Scotland	102±1.8	49±2.8	<0.001	<u>7.2</u>

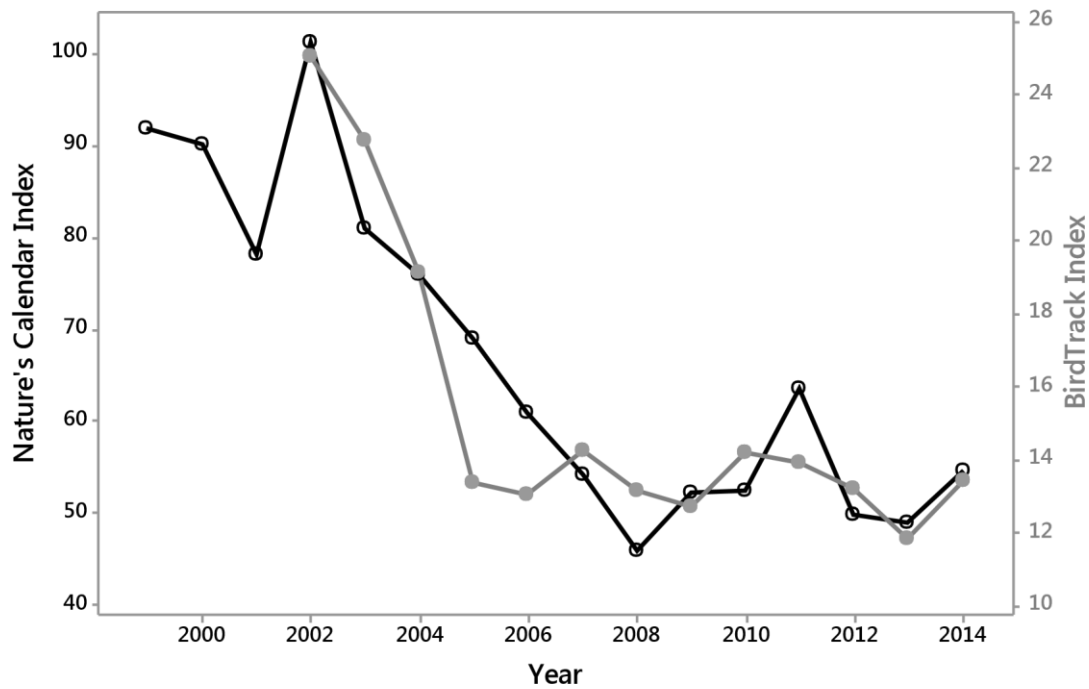


Figure 1. Cuckoo indices (Cuckoo records as a percentage of Swallow records) from Nature's Calendar (1999–2014; open symbols, black line, left hand axis) and BirdTrack (2002–2014; solid symbols, grey line, right hand axis).

### Appendix

An interesting by-product from the failure to hear Cuckoo analysis was derived from those records where recorders had volunteered to provide their age. We also examined the influence of age on hearing cuckoos. Our oldest age group of recorders experienced a significantly higher probability ( $\chi^2_{(2)}=36.66, p<0.001$ ) of not hearing Cuckoo despite them being the age group that was likely to have had greater first-hand experience of nature, and being taught nature study, when younger. We do not know if this reflects reduced hearing or reduced mobility in this group.



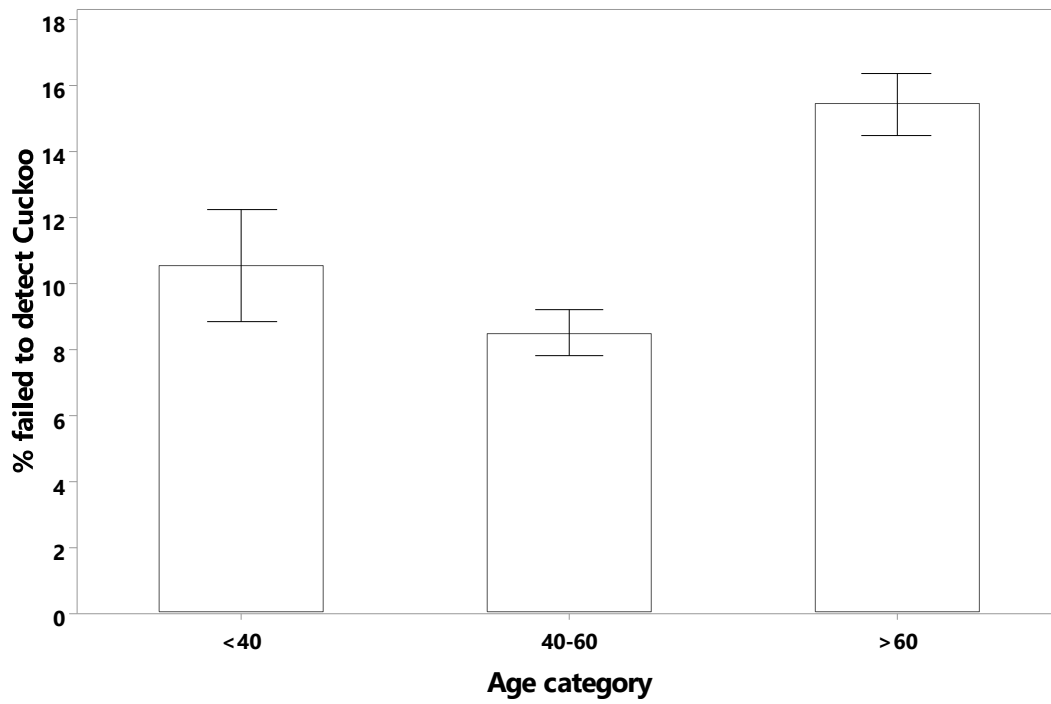


Figure 2. % failure ( $\pm$ SE) to detect cuckoo in spring in three recorder age categories (n=323, 1615, 1491 respectively).