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Is the detection of the first arrival date of migrating birds influenced by population size? A case study of the red-backed shrike *Lanius collurio*

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Abstract Many analyses do not consider the problems associated with the effects of population size on encounter recording. Population size could impact on the detection of bird arrival time as there is a higher probability of observing earlier arrival when the population size is greater and the song activity of birds is increased, as occurs with a larger population. As a case study, we have analysed data on the red-backed shrike *Lanius collurio* collected in Western Poland during 1983–2000. In this period the red-backed shrike's return to its breeding sites became significantly earlier whilst the contemporary population size increased significantly. To eliminate linear trends through time we have worked on the standardised residuals from regression of both arrival time and population size on year. The correlation between arrival time and population size residuals was significantly negative, further supporting the link between detection and population size. This finding suggests that, in studies of avian migration and its changes over time, the relationship between arrival date and population size needs to be considered.

Keywords Phenology · Birds · Population size · Migration

Introduction

When birds return to their breeding area is a key factor in studies of the impact of climate change upon bird populations (Berthold 1991; Čelakevičius 1997; Ahas 1999; Sparks 1999). However, many analyses do not consider

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the problems associated with the effects of population size. These could cause bird arrival to be detected earlier as there is (1) a higher probability of observing earlier arrival when the population is bigger, (2) increased song activity of birds relative to population size (Catchpole and Slater 1997).

Population size effects could be especially important for cryptic birds with a very secret biology that are not easy to detect in the field. The red-backed shrike *Lanius collurio* belongs to this category. In the period between arrival and nest building, the red-backed shrike is silent and the best method to detect this species is by observing either singing males or fights between males during the establishment of territories (Durango 1956b). Despite this secrecy, the red-backed shrike is a thermophilic species (foraging and resting in sunny locations) and changes in the arrival time and population size would be a good indicator of temperature or more general climate changes, as postulated by Southern (1941), Durango (1956a) and Van Nieuwenheuyse et al. (1999).

In this short paper we examine the relationships between the arrival time of birds and the size of the local breeding population.

Materials and methods

The study was conducted during the years 1983–2000, in the agricultural landscape of south-western Poland near Leszno (51°51'N, 16°35'E), where arable fields are interspersed with meadows, pastures and small woods. A detailed description of the study area is given by Kuźniak (1991).

The red-backed shrike is a long-distance migrant, spending the non-reproductive season in the southern part of Africa. In the study area the species nests in shrubs and trees at a height of 0.7–1.8 m. Complete clutches consisted of 2–7 eggs, with a mean of 4.9. About 40%–45% of clutches were lost, mainly through nest predation (Kuźniak 1991; Tryjanowski et al. 2000).

The main habitat of the red-backed shrike in the study area is strictly limited, because there are small tree islands among arable fields and meadows (Kuźniak and Tryjanowski 2000).

Observations of the first arrival dates of the red-backed shrike were recorded mainly by Stanisław Kuźniak, with occasional help from one of us (P.T.).

Within the study area, the size, and hence density, of the breeding population of the red-backed shrike in each year was estimated

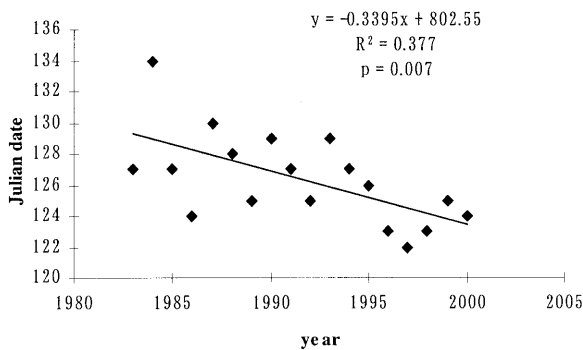


Fig. 1 Arrival dates (days after December 31) of the red-backed shrike in the study area

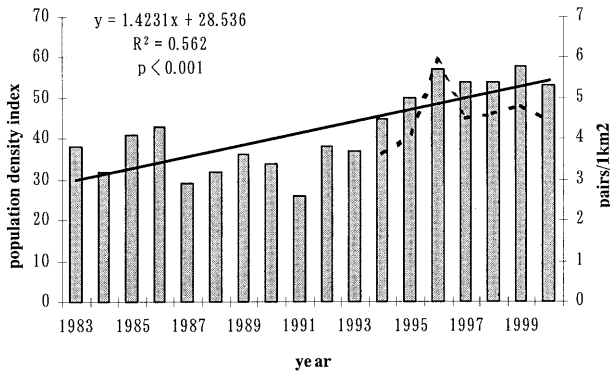


Fig. 2 Year-to-year changes in the population size. Vertical bars the population size estimated by the number of nests weighted by observer activity, dashed line the population size estimated by the mapping method. A regression line for the former series is superimposed

by the number of nests recorded weighted by the field observation activity for that year. Because this method is non-standard, we compared the results obtained by this method with the red-backed shrike density figures estimated by a mapping method supported by intensive nest searching. The second method was applied to an area of 10 km² during the years 1994–2000 (Kuźniak and Tryjanowski 2000).

Data satisfied the assumptions for parametric analysis, all basic statistical analyses were applied according to the recommendations of Sokal and Rohlf (1995) and were conducted using the statistical package SPSS/PC+ (Norusis 1994). Ringing results suggest a very high turnover of individuals between years and hence results from different years have been treated as independent observations (S. Kuźniak and P. Tryjanowski, unpublished data).

Results

Arrival time

In the study area the first red-backed shrike arrived between 2 and 13 May (median, 6 May). During the period 1983–2000 the red-backed shrike's return to its breeding sites became significantly earlier ($r = -0.614$, $P = 0.007$, Fig. 1).

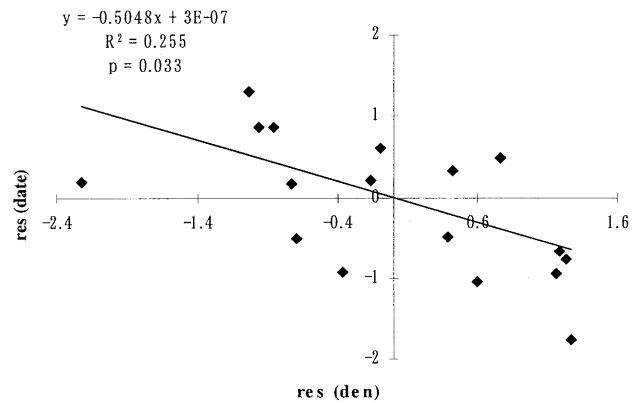


Fig. 3 The relationship between the residuals of first arrival time on year and the residuals of population size on year

Population size

We first correlated the population size estimates derived from the two methods for the 7 years in which both methods were used. A strong correlation existed between population size, estimated on the basis of nest searching weighted by observer activity and that estimated by the mapping method ($r = 0.882$, $P = 0.020$, Fig. 2). The local population size increased significantly ($r = 0.750$, $P = 0.001$) during the study period (Fig. 2).

There was a significant negative correlation between arrival date and population size ($r = -0.724$, $P = 0.001$). To test the validity of this correlation, we also worked on the standardised residuals after fitting (separately) both arrival time and population size on year, i.e. after eliminating a linear trend. The correlation between the residuals was still significantly negative ($r = -0.505$, $P = 0.033$), further supporting the link between arrival detection and population size (Fig. 3).

Discussion

The red-backed shrike belongs to a more cryptic group of birds and requires greater taxonomic skills than many readily apparent and easy-to-identify birds recognised by the general public as harbingers of spring (Sparks 1999). Hence, widespread data on the changes in arrival time of this species over the long term are lacking. However, its arrival time is very similar to that of other long-distance migrants in Central and Eastern Europe (Berthold 1991; Ahas 1999).

Sparks (1999) suggested the need to investigate the relationship between first arrival date and population size and identified a potential problem with the turtle dove *Streptopelia turtur*. However, this potential problem is rarely mentioned in other phenological papers. One reason for this may be the lack of contemporary data on both arrival and population size. Our results, obtained during studies of the red-backed shrike, indicate a strong relationship between an index of population size

and the arrival time. This is probably the effect of two factors acting simultaneously. First, a statistical bias will be caused by the higher probability of observing earlier arrival when the population size is larger. Second, there is a biological effect, for many bird species show evidence of increased song activity as the population size increases (Catchpole and Slater 1997) and hence may be observed earlier.

In conclusion, this finding suggests that, in studies of avian migration and its changes over time, the relationship between an arrival date and population size should be considered in any analyses.

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