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Use of call counts for estimating spring density of the Grey Partridge *Perdix perdix*

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Abstract. A method estimating the spring density of Grey Partridge using male call counts was tested. Vocal activity was found to be relatively constant between mid March and mid April. In this period, the average number of males heard at randomly-selected points in an area was strongly correlated with Partridge population density. Counts of calling males may be used to determine the spring density of Partridges: indiv./km^2 = $3.38x^{1.11}$ or pairs/km^2 = $1.45x^{1.16}$, where x = mean number of males heard at selected points. The number of randomly-selected single listening points (between 1 point per km^2 and 1 point per 10 km^2) should be chosen in accordance with the size of the area and the aim of determining the density.

Key words: bird census methods, Grey Partridge *Perdix perdix*, population density, voice, vocal activity.

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INTRODUCTION

The many methods used to estimate densities of the Grey Partridge include total census methods, as well as strip censuses and line transects (Mendel & Peterson 1980, Pepin & Birkan 1981, Ratti *et al.* 1983, Potts 1986, Schulz 1990, Birkan 1992). Most of these methods are expensive and time-consuming and may only be applied in easily-accessible areas.

Direct counts are often replaced, especially in the case of species that are difficult to observe, by indicators, i.e. counts of the traces or voices of animals. The presence of such indicators should be correlated with population density (Davis & Winstead 1980). In the case of the Partridge, the methods of this kind applied include counts of calls, which are produced most intensively at sunrise and sunset (March & Church 1980, Weigand 1980, Rotella & Ratti 1986, Moyles & Lester 1987, Birkan 1992, Novoa 1992). According to Rotella & Ratti (1986), the average numbers of Partridges heard in spring and summer at selected points in an area were correlated with population density and could be used as an indicator of it. However, the authors stressed the necessity of further studies on the reliability of this indicator, and their method was itself disputed (Guthery 1989, Ratti & Rotella 1989).

The object of the present study was to develop a method by which to determine the spring density of Partridges on the basis of a call count. The questions to be answered concerned:

1) whether the birds produced calls of equal intensity in the morning and in the evening in spring, and if so for which period;

2) whether and in what way the results of call counts were correlated with population density.

STUDY AREAS

The study was conducted in the years 1988–1994, in three areas of open and flat agricultural landscape covering about 100 km^2: Czempiń (Western Poland), Socha-

czew (Central Poland) and Lublin (Eastern Poland). The crop fields were small, at between less than 1 ha and 5 ha. In early spring, 28–35% of each study plot had winter cereals, 3–7% alfalfa clover or grasses, and 1–3% permanent spontaneous vegetation (as balks, ditches or roadsides). The remaining parts of fields were plowed and typically smoothly harrowed during the time of the field study.

METHODS

Call counts of Partridges were made in the morning or evening, at selected points in each area. Places close to sources of noise (for example main roads) were avoided. Counts were not made during windy or rainy weather, as this might have affected vocal activity (Rotella & Ratti 1988, Pepin & Fouquet 1992). All counts were made at temperatures ≥ 0°C.

As Partridges mainly produce their calls during 30–45 minute periods before sunrise and after sunset, with perceptible peaks of activity 30–15 minutes before sunrise and 15–30 minutes after sunset (Rotella & Ratti 1986, 1988), the researcher arrived at the selected point before the expected period of most intensive Partridge calls and stayed there to the end of this period. A call count determined the number of males heard at the selected point, but as the same individual might be heard at several places, the principle of simultaneous identification was applied to distinguish between males, especially those heard close to one another. The researcher also registered the flights which were sometimes seen or heard.

According to Rotella & Ratti (1988), the "kee-uck"or "kerr-r-r-r-r-ik" call of the Partridge differs in duration from season to season. Dessi-Fulgheri *et al.* (1986) defined a longer territorial call produced by males in spring and summer, and a shorter "rally" call most often produced in autumn and early winter. It was the territorial call that was mainly heard during our counts, and only this type of call was taken into account.

Changes in vocal activity during various periods of spring were observed in one study area (Czempiń, Western Poland) in the two years 1988 and 1991. This area had 5 selected listening points in the first year and 3 in the second (after an increase in Partridge density). Evening counts of calling males were made at all these points once per ten-day period between the beginning of March and mid May. The acquisition of data began following dispersion of winter coveys and the formation of pairs — i.e. after about a month in the first year and 2 weeks in the second year. No data were obtained for 2 ten-day periods in 1988 because of bad weather conditions. Morning counts were also made in some ten-day periods. Numbers of males heard at all points were summed and then compared between ten-day periods.

The ratio between call count results and population density was studied in the years 1988–1991 by simultaneously determining both parameters in study plots of between 2.7 and 3.4 km^2 situated in the three areas. One plot in a given area was selected each year, giving 12 different plots during the four years. A total census of Partridges was performed on these plots in the second half of March or first half of April. All fields and structures with spontaneous vegetation were searched thoroughly with a trained dog. Moreover, Partridges on the plowed and smoothly-harrowed fields covering over 50% of an area, could easily be noticed through binoculars. The penetration of an area was facilitated by the dense mosaic of small fields and the poor vegetation in the study period. On average, it took 5 hours to count all the birds in a 1 km^2 area. Simultaneously, between mid March and mid April, one evening call count was performed at each of 3 points per study plot (i.e. about 1 point per km^2). Points were chosen at random, but were separated by at least 500 m from the plot edge and from each other. The average numbers of males heard at listening points were then compared with densities determined for plots.

The precision of estimates of average numbers of males heard in relation to the number of listening points located on large plots was tested in the years 1992–1994 in the three c. 100 km^2 study areas. Fifteen points in each area were selected randomly, and a call count performed at each between mid March and mid April each year. The ratio of standard error to mean (SE/mean) was calculated and compared for various numbers of listening points.

RESULTS

Vocal activity was relatively constant between mid March and mid April (Fig. 1). The total numbers of

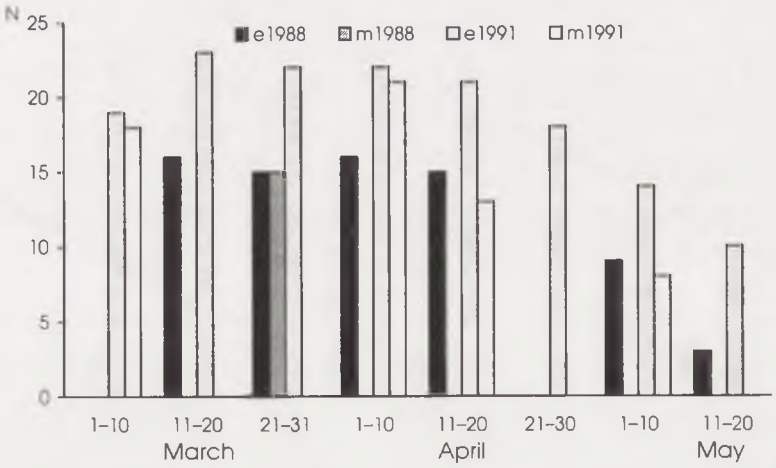

Fig. 1. Total numbers of males (N) heard at the same points in the field during consecutive ten-day periods in two years. e — evenings, m — mornings.

[Rys. 1. Łączne liczby samców (N) słyszanych w tych samych punktach terenu podczas kolejnych dekad. e — wieczorem, m — rano.]

males heard at the same points in the evenings between 11 March and 20 April ranged from 15 to 16 (mean = 15.5, SD = 0.6, n = 4) within various ten-day periods in the first year and from 21 to 23 (mean = 22.0, SD = 0.8, n = 4) in the second year. Evening vocal activity decreased in both years between 11–20 April and 11–20 May ($r = -0.982$, $df = 1$, $p = 0.1$ and $r = -0.998$, $df = 2$, $p = 0.002$). The results of morning and evening counts were similar from the beginning of March to 10 April, but afterwards fewer males were heard in the morning than in the evening (Fig. 1).

Spring densities on 12 study plots in the three study areas ranged from 1.7 to 22.0 pairs per km^2 (mean = 10.3, SD = 6.0) or from 4.2 to 47.7 individuals per km^2 (mean = 21.8, SD = 12.9), while average numbers of males heard ranged from 1.0 to 9.3 (mean = 5.2, SD = 2.5). The average number of males heard was strongly correlated with population density (Fig. 2), though, the linear regression lines describing this relationship did not pass through 0. Moreover, the proportionality between the number of males heard and the density of pairs (ranging from 0.42 to 0.72 with a mean of 0.54) decreased slightly with increasing density ($r = -0.799$, $df = 10$, $p = 0.002$), such that power curve regressions were applied (Fig. 2). Population density (y) may be calculated on the basis of the average number of males heard (x), in accordance with inverse regressions, on the basis of the equations: $y(\text{individuals/km}^2) = 3.38x^{1.11}$ ($SE_{Fst} = 0.14$) or $y(\text{pairs/km}^2) = 1.45x^{1.16}$ ($SE_{Fst} = 0.13$).

The average number of male Partridges heard at the 15 points in the three study areas ranged from 2.1 to 9.7 in the years 1992–1994, with a mean of 6.0 (n = 9). The SE/mean ratio (an index of the precision of estimated average numbers of males heard) was calculated for various numbers of points (from 2 to 15) and next averaged for the three areas and years. Average values for the ratio decreased with an increased number of points ($df = 12$, $r^2 = 0.987$, $p < 0.0001$, $y = 0.41x^{-0.45}$), but there was a tendency towards stabilization with more than about 10 points (i.e. 1 point per 10 km^2). The ratio had a value of 0.14 for 10 points and 0.12 for 15 points (ranging from 0.08 to 0.24 and from 0.07 to 0.18, respectively, for different areas and years).

DISCUSSION

If a count of calling males is to be an indicator of Partridge population density, the intensity of vocal activity must be constant during some period. This requirement appeared to be fulfilled in both the morning and evening over a period of more than one month. Rotella & Ratti (1986) also found no differences in morning and evening activity in spring, but did not study within-season variability. Weigand (1980) noticed a decrease in vocal activity from the end of April of the kind seen in the present study and he attributed it to the beginning of the nesting season. In Poland,

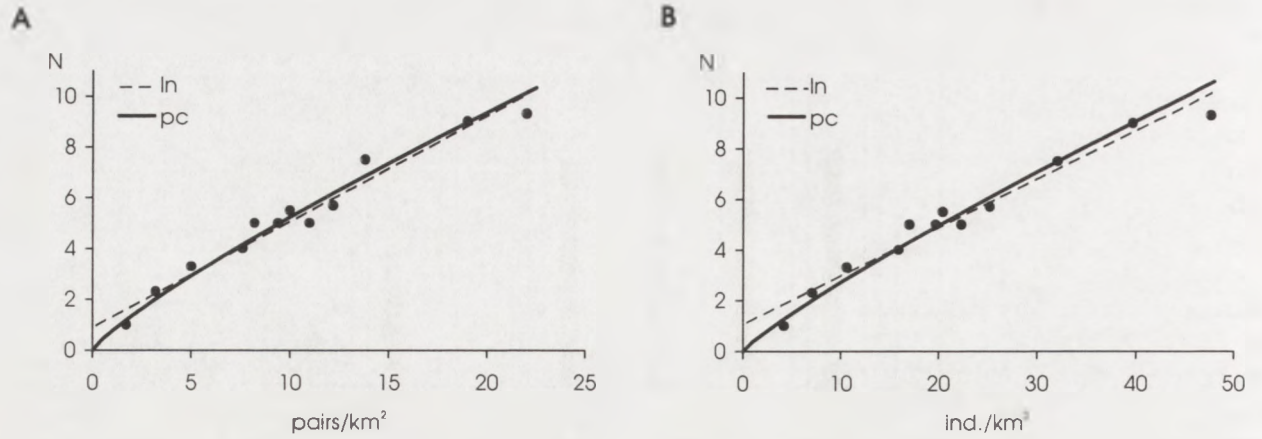

Fig. 2. Relationships between average number of males (N) heard at count points and population density recorded in the same area: A. Linear regression (ln): df = 10, $r^2 = 0.959$, $p < 0.0001$, $y = 0.41x + 1.04$. Power curve regression (pc): df = 10, $r^2 = 0.972$, $p < 0.0001$, $y = 0.76x^{0.84}$; B. Linear regression (ln): df = 10, $r^2 = 0.960$, $p < 0.0001$, $y = 0.19x + 1.09$. Power curve regression (pc): df = 10, $r^2 = 0.963$, $p < 0.0001$, $y = 0.37x^{0.87}$.

[Rys. 2. Relacje między średnią liczbą samców (N) słyszanych w punktach liczenia a zagęszczeniem populacji stwierdzonym w tym samym terenie.]

Partridges begin laying in the second half of April (Chlewski 1980), so this again coincides with the proven decrease in vocal activity.

Rotella & Ratti (1986) suggested that only morning call counts could be used as an index of Partridge density. However, their counts were performed during spring and summer, and calling frequency during summer evenings was not directly related to population density. In contrast, evening counts were preferred in the work described here, because the results of morning counts might be disturbed by the intensive song of Skylark *Alauda arvensis*, which started in the period of Partridge vocal activity. The detectability of calling males probably decreased in the morning in areas of high Skylark density.

Average numbers of male Partridges heard at selected points in an area were strongly correlated with population density. Thus, when combined with the quoted equations, call counts of males may be used to estimate the spring density of Partridges. Counts by this method ought to be made after the formation of pairs and within a month of the start of the nesting season. In conditions similar to those in Poland, an appropriate period would be between mid March and mid April. Although pairs of Partridges usually form before the middle of March in Poland (M. Panek, unpubl. data), it would not seem useful to begin counts this early in view of the pre-breeding mortality.

The proportionality between numbers of males heard and population density decreased slightly with increasing density, suggesting somewhat lower detectability of males. However, the average numbers of calling males were approximately half the figure for the density of Partridge pairs per km^2. This suggests that registration pertained to males frequenting an area of at least 0.5 km^2, or within a minimum radius of 0.4 km. Thus, the distance between listening points should be at least 1 km, if possible with regard to the size of the study area.

The number of randomly-selected single listening points should be chosen in accordance with the size of the area and the aim of determining density. In the case of a detailed study in areas of a few km^2, at least 1 point per km^2 is appropriate (but a minimum of 3 points for plots < 3 km^2). Estimates of Partridge density in larger areas of say 10 to 100 km^2 should have a recommended minimum of 10 listening points.

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Revision of English by dr James Richards

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STRESZCZENIE

[Liczenia odzywających się samców jako metoda oceny wiosennego zagęszczenia kuropatw]

Badania zmierzające do opracowania metody oceny wiosennego zagęszczenia kuropatw poprzez liczenia odzywających się samców prowadzono w latach 1988–1994 na trzech terenach położonych w różnych regionach Polski. Liczenia, wykonywane w czasie 30–45 minutowej intensywnej aktywności głosowej kuropatw o świcie lub o zmierzchu, polegały na określeniu liczby samców słyszanych w wybranych punktach terenu. Zmiany aktywności głosowej kuropatw między początkiem marca a połową maja były oceniane na jednym z terenów w ciągu 2 lat, poprzez liczenia odzywających się samców w tych samych punktach w kolejnych dekadach tego okresu. Relację między wynikami liczeń odzywających się samców a zagęszczeniem kuropatw badano na 12 powierzchniach (każda wielkości około 3 km^2), położonych na trzech terenach. Na powierzchniach tych, w drugiej połowie marca lub w pierwszej połowie kwietnia, określono zagęszczenie kuropatw metodą szczegółowego przeszukiwania terenu z psem, oraz przeprowadzono jednorazowe liczenia odzywających się samców z trzech losowo wybranych punktów.

Pomiędzy połową marca i połową kwietnia aktywność głosowa kuropatw była względnie stała, ale zmniejszała się w drugiej połowie kwietnia i w pierwszej połowie maja. Średnie liczby samców słyszanych w wybranych punktach były silnie skorelowane z zagęszczeniem kuropatw. Zagęszczenie kuropatw (y) może być wyliczone ze średniej liczby słyszanych samców (x) przy użyciu równań: $y(\text{osob./km}^2) = 3{,}38x^{1.11}$ lub $y(\text{pary/km}^2) = 1{,}45x^{1.16}$.

Oceny wiosennego zagęszczenia kuropatw metodą jednorazowego liczenia odzywających się samców, słyszanych z losowo wybranych punktów terenowych, mogą być prowadzone po rozpadzie stadek zimowych i utworzeniu się par, oraz w ciągu miesiąca przed rozpoczęciem sezonu gniazdowego — w warunkach Polski zwykle od połowy marca do połowy kwietnia. Liczenia powinny być prowadzone podczas dobrych warunków pogodowych, przede wszystkim bez silnego wiatru i deszczu. Rekomendowane są liczenia wieczorne, ponieważ o świcie słyszalność kuropatw może się zmniejszać w związku z intensywnym śpiewem

skowronków, rozpoczynającym się w czasie aktywności głosowej kuropatw. Liczba punktów słuchania powinna być dobrana w zależności od wielkości terenu i celu ocen zagęszczenia. W przypadku szczegółowych badań na powierzchniach rzędu kilku km^2, proponuje się minimum 1 punkt na km^2, natomiast dla oszacowania zagęszczeń tego gatunku w terenach rzędu kilkudziesięciu km^2, zalecanych jest co najmniej 10 losowych punktów słuchania.

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