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ORIGINAL PAPER

Monitoring Grey Partridge (*Perdix perdix*) Populations in Poland: Methods and Results

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Abstract
The grey partridge (*Perdix perdix*) population in Poland is monitored by the Polish Hunting Association. Apart from information on hunting bag in the whole country (1981-2002), also demographic data are collected every year in selected areas (50-150 km^2) located in various regions of Poland (three such areas in 1987-1990, 12 in 1991-1997, and 19-41 in 1998-2003). In the monitoring areas, spring partridge density (call counts in March/April), reproductive success (counts of adult and young birds in August) and annual survival rate of adult birds were estimated. The annual partridge hunting bag in Poland varied from 24,000 to 293,000 individuals between 1981 and 1992, and decreased to 20,000 - 22,000 birds in the years 2000-2002. In the 1990s, the average spring density of grey partridge in Poland showed a 3-fold decrease. In the early 2000s, 0.5 to 10.5 pairs per km^2 were recorded in individual areas. The reproductive success of partridges (annual values ranging between 1.2 and 3.4 young per adult) decreased through the years 1987 to 2002. The annual survival rate of adult birds (annual values ranging between 25 and 38%) did not show any significant trends during the monitoring period. The decrease of reproductive success and consequently the observed population decline probably resulted mainly from increased abundance of nest and hen predators, particularly red foxes.

Introduction

Data on grey partridge (*Perdix perdix*) hunting bag in Poland have been collected since the beginning of the 1960s. In the years 1960 through 1978 the annual hunting bag varied widely from 62,000 to 744,000 birds, but no long-term declining tendency was observed in this period. However, at the end of the 1980s, a considerable decrease in the hunting bag was noted [1]. A restriction of grey partridge hunting possibilities was an incentive for hunters to implement actions to increase the number of these birds on hunting grounds. The right selection of such actions required knowledge of the factors affecting the situation of partridges. Therefore, detailed population studies were carried out in the second half of the 1980s [2] and at the beginning of the 1990s the Polish Hunting Association initiated a grey partridge monitoring program in order to provide current information about changes in their density in Poland and the demographic mechanism causing such changes. The project is co-ordinated by the Game Research Station of the Polish Hunting Association in Czempiń.
This paper presents methods and results of grey partridge monitoring in Poland, in what concerns the range and changes in the hunting bag in the years 1981-2002 and the basic demographic data (spring density, reproductive success and annual survival rate) in the years 1987-2003.

Monitoring methods

Hunting bag

Data on partridge hunting bag were obtained from annual reports provided by all hunting districts leased by hunting clubs. The reports covered about 90% of hunting districts in Poland. They were prepared after each hunting year (April-March) and included, among other information, data on the hunting bag of all game animals harvested during the previous year. The reports were sent to the Game Research Station in Czempiń where they were processed and analysed.

Demographic data

Partridge populations were monitored on agricultural areas ranging in size from 50 to 150 km^2, located in various parts of Poland. In the years 1987-1990 demographic data were collected in three areas, and in the years 1991-1997 there were 12 permanent monitoring areas. Since the year 1998 their number increased and varied between 19 and 41. The monitoring areas were selected among hunting districts characterized by hunting bag of partridges (thus probably also their density level), which allowed obtaining close to average density values for a given region.

Spring counts of grey partridges were conducted and data about the composition of their population in August were gathered to evaluate the reproductive success. The spring density was estimated by call counts carried out from the 15th of March to the 15th of April. The call counts were made in the morning or evening during good weather conditions, at 10 points selected randomly on agricultural areas. Observers arrived at the selected points before the expected period of most intensive partridge calls (before sunrise or after sunset), and stayed there to the end of this period. The number of males heard at the selected point was recorded. 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 [3]. The density of partridge pairs (D) was calculated according to the formula: $D = 1.45x^{1.16}$, where x is the mean number of males heard at the selected points [3]. In August, the records included information about the size and age composition of all partridge coveys detected, integrating family groups or groups of adult birds without brood [4]. The annual number of observations registered in the whole country ranged from 174 to 503. The field work sessions were carried out by trained hunters.

The changes of average spring density of grey partridge in Poland were described with an use of relative values, as the monitoring areas partially changed year by year. The density value for the year 1998 (when there was an increase in the number of monitoring areas) was assumed as 1, and the values for previous and subsequent years were determined proportionally to the changes in the average density calculated for areas where call counts took place in two consecutive years. Using August data, the reproductive success of grey partridge in the country was calculated as the young/adult ratio among all observed birds. The annual survival rate (S) of adult grey partridges was calculated according to the formula: $S = D_{n+1}/[D_n \times (1+R)]$, where D_n

and D_{n+1} are respectively relative densities for a given and subsequent spring, and R is the reproductive success ([5], modified).
Temporal changes in partridge demographic variables were analyzed using simple correlation analysis.

Results

Hunting bag

In the 1980s the annual hunting bag of grey partridge in Poland varied from 24,000 to 223,000 birds and the average value for this decade was 2.5 times lower than that registered for both of the previous decades (Fig. 1). At the beginning of the 1980s as well as in the late 1980s and in the early 1990s some increase was observed, and consequently the hunting bag reached 293,000 individuals in the year 1992. However, a subsequent continuous decrease was recorded and in the years 2000-2002 only 20,000-22,000 grey partridges were hunted in Poland (Fig. 1).

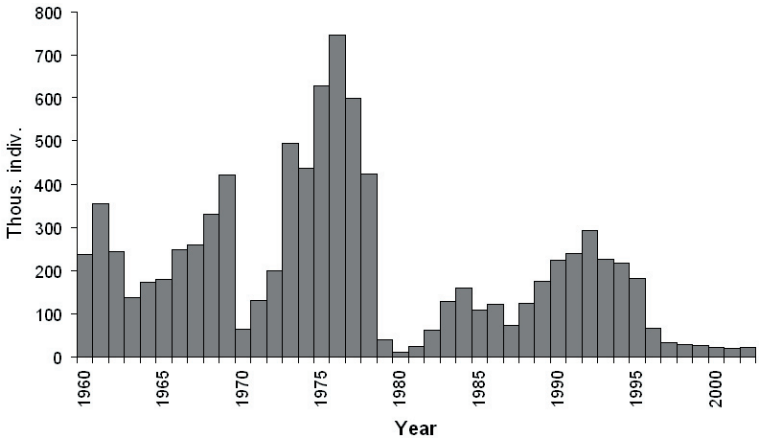

Fig. 1. Hunting bag of grey partridge in Poland in the years 1960-2002 (1960-1980 data were available in [1]).

Demographic data

The relative spring density of grey partridge in Poland increased at the end of the 1980s and it was virtually stable at the beginning of the 1990s. However, in the middle 1990s a considerable decrease was recorded. In the late 1990s the relative density was about 3 times lower than that recorded at the beginning of the decade. In the years 1998-2003, a slight increasing tendency was observed (Fig. 2). At the beginning of the 1990s, the average spring densities ranged from 4.6 to 18.7 partridge couples per km^2 across permanent monitoring areas (n = 12), and at the beginning of the 2000s, these values ranged from 0.5 to 10.5 couples per km^2 (n = 34). Densities in central and eastern Poland were higher than those noted in western, northern and southern regions of the country (Fig. 3).

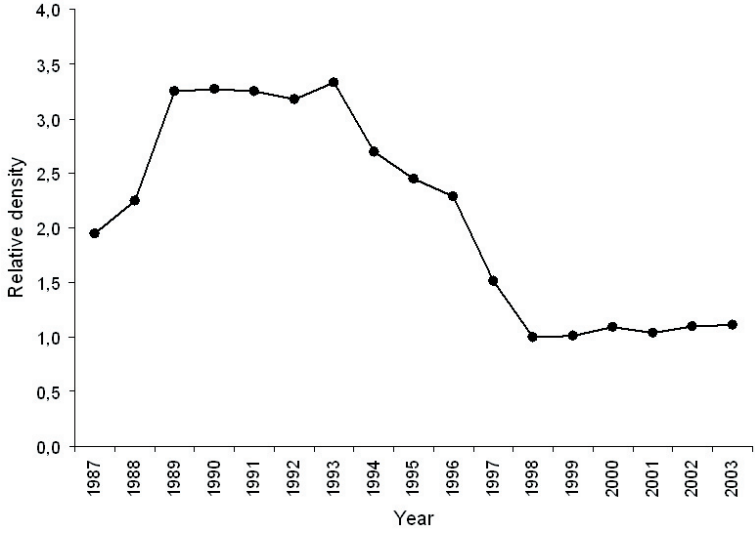

Fig. 2. Relative spring density of grey partridge population in Poland in the years 1987-2003 (the value for the year 1998 is assumed as 1).

Fig. 3. Average spring densities of grey partridge (pairs per km^2) in individual monitoring areas (n = 34) in Poland in the years 2000-2003.

The reproductive success of grey partridges in Poland in the years 1987-2002 varied from 1.2 to 3.4 young per adult (Fig. 4A) and showed a significant decreasing tendency ($r = -0.531$, $df = 14$, $P = 0.03$). The annual survival rate of adult partridges ranged from 25% to 38% (Fig. 4B) and no significant changes were found during the study period ($r = 0.248$, $df = 14$, $P = 0.4$). The annual changes of the relative spring density of partridges in the country were positively correlated with the reproductive success ($r = 0.834$, $df = 14$, $P < 0.001$), but not with the annual survival rate of adult birds ($r = 0.461$, $df = 14$, $P = 0.07$).

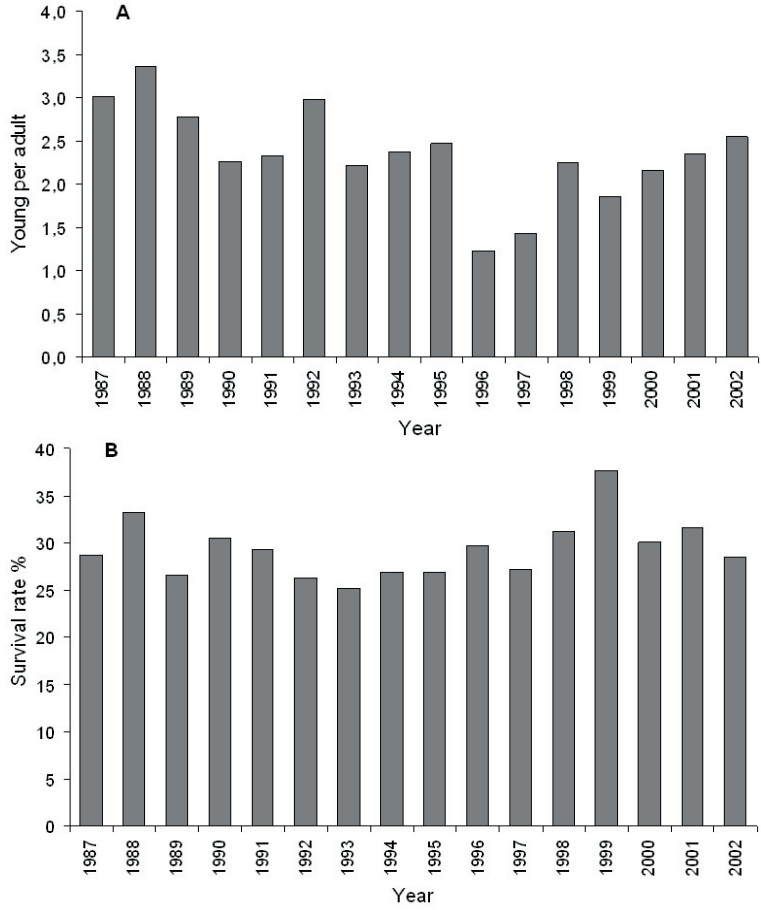

Fig. 4. Basic demographic variables of grey partridge population in Poland in the years 1987-2002. A. reproductive success; B. annual survival rate of adult birds.

Discussion

The results of grey partridge monitoring in Poland showed that the population decline in the 1990s was connected with the decrease of reproductive success. According to a more detailed analysis, the decline in the reproductive success was a result of changes both in brood production rate and in chick survival rate [6].

The brood production rate in grey partridge depends on the availability of nesting sites and on the abundance of nest and incubating hen predators [4]. The second factor seems to be the most important in Poland during the 1990s. In this decade the number of foxes in the country increased considerably [7]. It is possible that in this period also the abundance of other predators increased, for example racoon dog and mustelids, since their hunting bag in Poland increased significantly [8]. On the other hand, radiotelemetry studies conducted in western Poland revealed that the main cause of clutch and incubating female losses was predation by carnivores (81%), mainly red foxes [9]. Thus, the increased fox pressure during breeding season was probably one of the main reasons or even the most important reason for the decrease in partridge populations in Poland in the 1990s.

The major known phenomenon causing a long-term declining tendency of chick survival rate in grey partridge is an intensification of pesticide use [4]. In Poland, the use of pesticides per agricultural land unit decreased in the late 1980s and in the early 1990s, but later an increase was noted and in the second half of the 1990s, the pesticide use was 40% higher than in the first half of the decade [10]. This increase may have been another reason for the decrease of reproductive success and for the observed population decline.

According to the results of grey partridge monitoring in Poland, a project to improve the situation of this bird in the country should be, first of all, focused on measures that would allow increasing partridge reproductive success, such as reducing the predation pressure on nests and incubating females. The effectiveness of such measures have been confirmed experimentally elsewhere [11]. In Poland, the control of common predators operating during breeding season, especially red foxes, seems to be the most relevant management measure towards partridge conservation.

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