

ROCK PARTRIDGE (*ALECTORIS GRAECA*) RECOVERY PROGRAM: FIRST EVIDENCES ON SURVIVAL AND DISPERSION RATE OF SEMI-NATURAL REARED BIRDS IN 'VRACHANSKI BALKAN' NATURE PARK

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Received: 09 October 2018

Accepted: 20 January 2019

Abstract

Rock Partridge (*Alectoris graeca* Meisner, 1804) is endemic to Europe, occurring only in the Alps, the Apennines, Sicily and the Balkans. It is suspected to be declining moderately rapidly, particularly in the Balkans which hold a substantial proportion of the species population and range, based on a balanced assessment of the available evidence. Survival rates of 50 released rock partridges in typical habitats in 'Vrachanski Balkan' Nature Park were studied during the re-introduction program. Almost all released birds were monitored for 110 days. Twenty of them were marked with radio transmitters, which allowed the survival rate to be determined, dispersion and habitat preferences. Birds mortality reached 70 % at the end of survey period and only 6 (30 %) of them survived and bred in the next spring. Most birds (65 %) died in the first month after release due to predation. The main predators were mammals (92 % of mortality) while the avian raptors caused an insignificant part of mortality (8 % of mortality). In cold winter days with temperatures lower than -25 °C only one dead bird was found. The survival rates of Rock Partridges did not depend on sex ($\chi^2 = 0.05$, $p = 0.82$, $df = 1$) and age ($\chi^2 = 0.1$, $p = 0.9$, $df = 1$). The birds' dispersion varied from 35 m to 1.3 km. However only single birds moved more than 1 km away from the release point.

Key words: mortality, radio telemetry, survival rates.

Introduction

Rock Partridge (*Alectoris graeca* Meisner, 1804) is endemic to Europe, occurring only in the Alps, the Apennines, Sicily and the Balkans. It is suspected to be declining moderately rapidly, particularly in the Balkans which hold a substantial proportion of the species's population and range, based on a balanced assessment of the available evidence (Griffin 2011, Staneva and Burfield 2017).

Rock Partridge in Bulgaria belongs to the nominate subspecies *Alectoris graeca graeca* (Meisner, 1804) and is unique in the world due to the presence of a hybrid zone with Chukar Partridge (*Alectoris chukar kleini* J. E. Gray, 1830) in native range of the species (Petrov et al. 1969, Bernard-Laurent and Boev 1997, Nikolov et al. 2007).

The species is Near Threatened (NT) classified in SPEC 1 with declining population trends (Staneva and Burfield 2017).

Rock Partridge is a species from the Red Data Book of Republic of Bulgaria. It falls into endangered category by applying the IUCN criteria at regional level (Boev and Nikolov 2011). Population size is estimated to be between 800–1500 breeding pairs. It is a priority of conservation (Biodiversity Act, Annex 2) and under regime of protection and regulated use (Nikolov et al. 2007, Staneva and Burfield 2017).

Rock Partridge has been widely distributed in Bulgaria during the 19th and early 20th centuries (Nikolov et al. 2007). The population decline began in the 1960s of last century (Donchev 1961, Simeonov et al. 1990). The beginning of the 1990s, the Rock Partridge number as about 20,000 individuals (Simeonov et al. 1990). The population size decreases from 5–10,000 breeding pairs to 1995 to 800–1500 pairs by 2002 (Staneva and Burfield 2017). This decline is also reported in 2007 (Nikolov et al. 2007). As limiting factors for Rock Partridge in other parts of the range are mentioned genetic hybridization (Triantafyllidis et al. 2005), predation (Vavalekas et al. 1993) and the abandonment of extensive agriculture and livestock, leading to increased canopy cover (Papaevangeliou et al. 2001, Rippa et al. 2011). The slope, the distance of forest and the presence of bare rocks are important factors for its reproductive zones (Amici et al. 2009). Rock Partridge preferred open areas with meadow and pastures at high altitude with south steep slopes with bare rocks (Cattadori et al. 1998, Sorace et al. 2013). The decline of mountain farming and hybridization with farm Chukar Partridge are one of the probable reasons for disappearance of Rock Partridge in most of habitats in Bulgaria (Nikolov et al. 2007). No specific studies have been conducted in Bulgaria on these cases.

The purpose in this study is to estab-

lish the survival rate, causes for losses and dispersion of Rock Partridges, reared under semi natural conditions.

Material and Methods

Field methods

At the beginning of November (09.11.2016), 20 Rock Partridges with radio transmitters (RI-2B, Holohil systems LTD) weighting 8 grams were released in 4 parts in 'Vrachanski Balkan' Nature Park (NW Bulgaria) (Fig. 1). The average weight of the birds was 510 g (420–570, $n=50$). The transmitter averaged 1.6 % of the weight. Almost all released birds were monitored for 110 days. They were released with another 30 unmarked Rock Partridges. The idea was to create a few flocks to be monitored. The birds were divided into IV groups (Fig. 1). In groups I, III and IV, we marked one bird over 1 year old and 3 at the age of 150 days, along with 8 non-marked birds aged 150 days. Only in group II were 2 birds over 1 year, 6 at 150 days and with them we released another 4 unmarked birds at 150 days of age. The release groups are consistent with the flocks in the breeding facilities.

All birds were reared under semi-natural conditions. In aviaries with an area as about 300 m² 4 males and 4–5 females were settled. In each aviary, rocks occupy 15–30 % of the area and natural shelters offering nesting sites. In addition, artificial shelters and nests were built. The aviary were equipped with automated feeders and water slots which do not require a daily human presence. The human presence was directly monitored once a week. During the rest of the time, the birds were monitored by video control. The habitats in which they were released fall into the

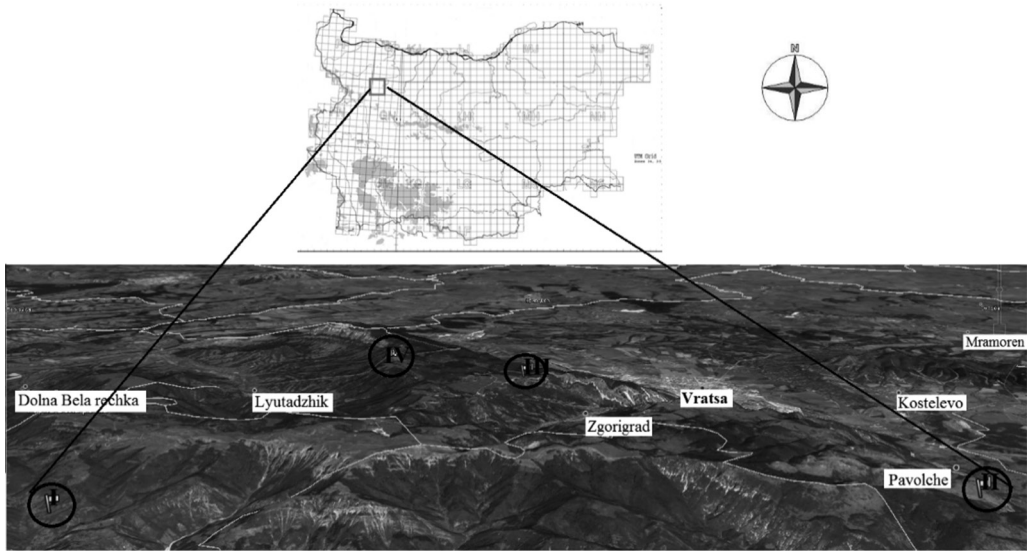


Fig. 1. Study area and places of release of radio tagged Rock Partridge (pointer I to IV – place of release of four groups Rock Partridge).

natural range of Rock Partridge and include typical areas.

Initially, Rock Partridges were located at a 3-day interval in the first month. The goal was to accurately determine the cause of losses. They were then located within 6 days until the end of the study because the losses decrease after the first month. Survival probability decreased very fast during the first 50 days from the capture and then more slowly (Meriggi et al. 2002). Each bird or flock found was observed visually during each telemetry. When not detected during the telemetry, the protocol was reported as non-localized. All distances were measured using the Garmin eTrex Legend Global Positioning System and the program MapSource, Version 6.11.6 (Garmin Ltd.).

Mortality

Losses were classified according to cause of mortality in the following categories:

predatory mammals; birds of prey; hunting activity and unknown. The reason for the death of birds has been established by using the traces left on the transmitter and the remains of feathers and bones around it.

The dispersion of birds after release was established as the mean arithmetic distance of each tagged bird from the release point for the entire monitoring period.

Statistical methods

The differences in bird dispersion at different release sites were tested with Mann-Whitney U test with Bonferroni corrected p values. Survival rates were estimated using Kaplan-Meier nonparametric analysis or product-limit estimator (Kaplan and Meier 1958, Pollock et al. 1989) and parametric survival curve analysis with Weibull distributed errors (Pinder et al. 1978, Crawley 2013). The differences in

survival rates between age and sex of released birds and the interaction between age and sex were tested by log-rank test (Krebs 1999), Cox proportional hazards model (Cox and Oakes 1984) and parametric model with Weibull errors (Pinder et al. 1978). A parametric survival curve analysis is less subject to the sensitivities of small sample sizes and stochastic variability observed in Kaplan-Meier nonparametric analysis (Kaplan and Meier 1958, Skalski et al. 2005). All statistical analyses were performed using R (R Core Team 2014) and package survival, v. 2.37-7 (Therneau and Grabsch 2000, Therneau 2014).

Results

Mortality

Overall mortality amounts to 70 % (Fig. 2). In the first month after release, 13 (65 %) of the tagged Rock Partridges died (Table 1). The main reason of death is predatory mammals – 12 from 14 dead birds (six birds killed by Red Fox *Vulpes vulpes* (Linnaeus, 1758); two killed by Wild Cat *Felis silvestris* (Schreb., 1777); 2 killed by Mustelidae and 2 was with undetermined

mammals. Birds of prey are the cause of the death of single partridges (one killed by a Goshawk *Accipiter gentilis* (Linnaeus, 1758)). Losses during the cold winter days, including temperatures of -25 degrees, amount to one dead bird (row 6 in Table 1) with cause for death – predatory mammal. Thirty percent of Rock Partridges survived after 110 days and bred in the spring of 2017.

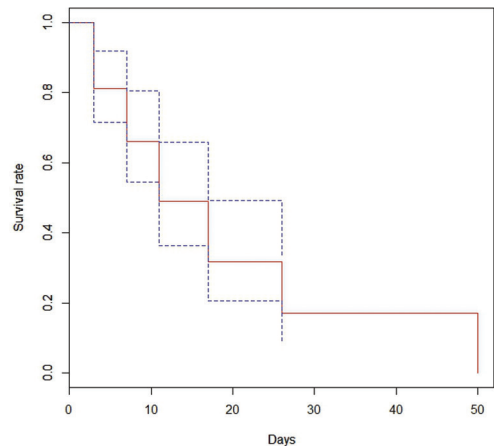


Fig. 2. Kaplan-Meier survival rates. Dashed lines show the 95 % confidence interval limits.

Note: mortality was shown during the first 50 days after release because there were no dead birds between the 50–110 days.

Table 1. Losses after release by sites of release and sex of birds.

Sites, days	I		II		III		IV		Total by sex		Total
	male	female	male	female	male	female	male	female	male	female	
3 days	0	0	2	2	0	1	1	2	3	5	8
7 days	1	1	0	1	0	0	0	0	1	2	3
11 days	0	0	0	0	0	0	1	0	1	0	1
17 days	0	0	0	0	0	0	0	0	0	0	0
26 days	0	0	0	0	0	0	0	1	0	1	1
50 days	0	0	0	0	1	0	0	0	1	0	1
110 days	0	0	0	0	0	0	0	0	0	0	0
Total	1	1	2	3	1	1	2	3	6	8	14

There is no difference in the survival rate by sex ($\chi^2=0.05$ on 1 degrees of free-

dom, $p=0.82$) and by age ($\chi^2=0.01$ on 1 degree of freedom $p=0.9$) (Fig. 3).

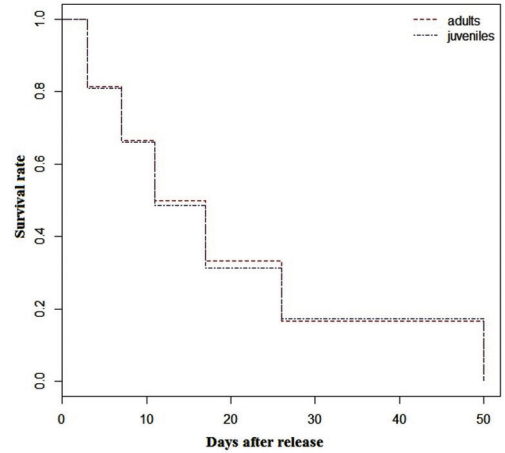
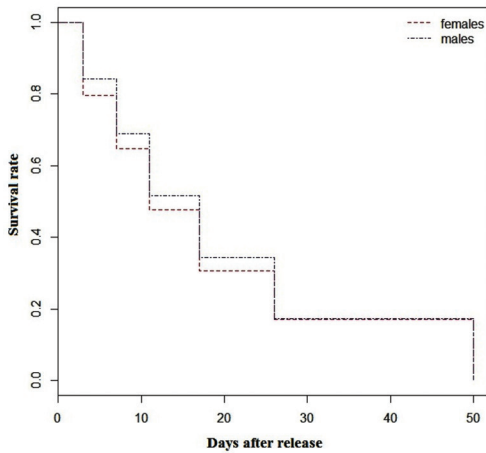


Fig. 3. Kaplan-Meier rates.

Dispersion

The dispersion varies from 35 m to 1.3 km but only single birds move more than 1 km away from the place of release (Table 2).

The dispersion of partridges released in place II and III is considerably smaller than that in other places (Table 3).

Table 2. Dispersion of Rock Partridges from points of release.

Place of release	Dispersion – Mean±Std Dev (min–max), m
I	500.7±70.3 (385–605)
II	276.4±150.4 (35–464)
III	504.3±291.1 (72–1300)
IV	339.3±222.1 (56–748)

Table 3. Results from Mann-Whitney U test with Bonferroni corrected p values between dispersion of rock partridges (p; U).

Places of release	I		II		III		IV	
	p	U	p	U	p	U	p	U
I	-	-	0.0018	8	0.633	59	0.072	22.5
II	0.0018	8	-	-	0.0081	31	0.549	46
III	0.633	59	0.0081	31	-	-	0.11	46
IV	0.0723	22.5	0.549	46	0.114	46	-	-

Note: in bold there are values where there is statistical significance at the corresponding value of U.

Discussion

Mortality

The results show the large losses in the first days after release (Fig. 2). There are no differences between by age and sex. The results obtained in confirm some already known ones in the other gallinaceous bird (Bernard-Laurent 1989, Bernard-Laurent and Léonard 1998). Losses after release are highest in the first week. The main causes for dead are predatory mammals – Red Fox, Wild Cat and different mustelids. Birds of prey have no significant impact on survival of partridges in this study. Similar results have been obtained from Chukar Partridge (*Alectoris chukar*) in Bulgaria (Gruychev 2012). In this study, a higher survival rate was found, in contrast to that found in other partridges in Bulgaria (Gruychev 2012). The probable cause is the semi-natural breeding and rearing of birds.

The survival rate found in this study is similar to that found by Duarte and Vargas (2004) for Red-legged Partridge (*Alectoris rufa*). High survival rate of gallinaceous birds reared in semi-natural environment was found in previous studies (Dowell 1990a, b; Buner and Schaub 2008; Slaugh et al. 1992; Alonso et al. 2005). This requires natural and semi-natural breeding to be preferred methods for reintroduction of a species into nature. The releasing of hand-reared gallinaceous birds remains common method for sustaining higher hunting bags and supporting wild populations (Game conservancy 1994, Ellis et al. 1978, Slaugh et al. 1992, Buner and Schaub 2008).

Dispersion and habitats

Our results indicate a relatively small dispersion of the released Rock Partridges. Only a single birds move more than one kilometer away. Various studies in gallinaceous birds provide different information about the distance from the marker. In France, *Alectoris graeca saxatilis* (Bechstein 1805) ranged between 4 and 25 km depending on the season, and these distances increased significantly after the beginning of the breeding season and subsequently the birds returned again near the marked point (Bernard-Laurent 1991). A number of studies indicate a relatively small area of the inhabited area of partridges (Lindbloom 1998; Walter 2000, 2002; Gruychev and Mihaylov 2015). Results of dispersion of released Chukar Partridge and Pheasant (*Phasianus colchicus*), also reported small distance of the birds from the place of marking (Gruychev 2012, 2014; Mihaylov et al. 2014). The probable cause for our results may be the high habitat suitability of the release sites characterized by presence of numerous vertical rocks in which birds find shelter. There they are undisturbed and remain almost throughout the day, except for the time they forage. Other possible could be that the partridges tend to stay near feeders. Unlike previous studies on partridges and pheasants in Bulgaria (Gruychev 2012, 2014; Gruychev and Mihaylov 2015), this study provides their importance. The released birds regularly visited the feeders during the cold winter days. This probably reduced the dispersion.

The raised of Rock Partridge in semi-natural environment is one of the

possibilities for recovery of the species in 'Vrachanski Balkan' Nature Park.

Conclusion

This study presents first results of recovery program of Rock Partridge in Bulgaria. The results show the large losses in the first days after release. There is no relation between losses by age and sex. Our results indicate a relatively small dispersion of rock partridges. Only a single birds move more than 1 km away. The predation remains the main cause of losses. The dispersion is relatively small and probably due to the vertical rocks that are important for the birds survival. Further research is needed to confirm the success of the recovery program in 'Vrachanski Balkan' Nature Park.

Acknowledgements

The investigations were carried out under grant: 'Implementation of planning and management activities of 'Vrachanski Balkan' Nature Park' part of Operational Programme Environment.

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