sciendo

Ornis Hungarica 2022. 30(1): 80–96.
DOI: 10.2478/orhu-2022-0006

The current status of Chukar (*Alectoris chukar* J. E. Gray, 1830) in Armenia

Karen Aghababyan[1*], Nicholas J. Aebischer[2] & Sevak Baloyan[3]

Received: February 15, 2022 – Revised: May 03, 2022 – Accepted: May 04, 2022

Aghababyan, K., Aebischer, N. J. & Baloyan, S. 2022. The current status of Chukar (*Alectoris chukar* J. E. Gray, 1830) in Armenia. – Ornis Hungarica 30(1): 80–96. DOI: 10.2478/orhu-2022-0006

Abstract The Chukar *Alectoris chukar* is one of the most popular game birds of Armenia, but there is no governmental monitoring programme for that exploited species. We carried out national surveys in 2003–2019 and estimate the current occupied range of the Chukar in Armenia as 5,082 km^2 (17% of the country). In 2019, we estimate Chukar population size at 12,472 breeding pairs (95% CL: 10,266–14,677). Its population trend shows a moderate decline underlying strong annual fluctuations. In Armenia, the Chukar occurs on 20 public hunting lands covering 2,414 km^2 in total. Its abundance on these public hunting lands is estimated to 5,558 breeding pairs in 2019 (95% CL: 3,656–7,460). Surveys of the seven Hunters' Unions of Armenia found that there are 10,000 to 20,000 active hunters. The number of hunting permits issued annually increased ten-fold between 2016 and 2019, exceeding the capacity of the public hunting lands in 2019. A hunter survey found that each Chukar hunter shot on average (± SD) 5.88±3.05 birds in the 2018/19 season, which extrapolates to 17,052–34,104 shot specimens of Chukar (at least 46% of autumn numbers). Current hunting management practice is thus unsustainable and we provide recommendations for sustainable approaches that should replace it urgently.

Keywords: game birds, distribution, population, hunting, management

Összefoglalás Bár a csukár *(Alectoris chukar)* Örményország egyik legismertebb vadászható madárfaja, jelenleg nincs állami állomány-felmérési protokoll erre a fajra. Országos felméréseket végeztünk 2003–2019 között, ami alapján 5082 km^2-re (az ország 17%-ára) becsültük a csukár jelenlegi elterjedési területét. 2019-ben a faj örmény állományának méretét 12 472 költőpárra becsültük (95% CL: 10 266–14 677). A faj állománytendenciája mérsékelt csökkenést mutat, erős éves ingadozással. Örményországban a csukár 20 állami vadászterületen fordul elő, összesen 2414 km^2-en. Egyedszámát ezeken a vadászterületeken 2019-ben 5 558 költőpárra becsültük (95% CL: 3 656–7 460). A hét örmény vadászszövetség felmérései szerint 10 000–20 000 aktív vadász került regisztrálásra. Az évente kiadott vadászati engedélyek száma 2016–2019 között a tízszeresére nőtt, meghaladva a 2019-es közcélú vadászterületek kapacitását. Egy vadászati kutatás megállapította, hogy egy csukárvadász átlagosan (± SD) 5,88±3,05 madarat lőtt ki a 2018/2019-es időszakban, ami alapján a valós szám 17 052–34 104 között mozog az extrapoláció alapján, ami az őszi számok legalább 46%-a. A jelenlegi vadászati gyakorlat ezért fenntarthatatlan, és így javaslatokat teszünk olyan fenntartható megközelítésekre, amelyek ezt sürgősen felváltják.

Kulcsszavak: vadászható madárfaj, elterjedés, populáció, vadászat, állománykezelés

[1] BirdLinks Armenia (former TSE Towards Sustainable Ecosystems) NGO, 87b Dimitrov, apt 14, 0020 Yerevan, Armenia
[2] Game & Wildlife Conservation Trust, Burgate Manor, Fordingbridge, Hampshire SP6 1EF, UK
[3] Bioresources permitting division, Ministry of Environment of RA, Republic Square, Government House 3, 0010 Yerevan, Armenia
** corresponding author, e-mail: karen.aghababyan@gmail.com*

Introduction

Armenia is a relatively small (29,743 km^2), landlocked mountainous country situated in South Caucasus between the Black and Caspian Seas, within the Western Palearctic. Elevation varies from 375 to 4,090 m above sea level, determining a variety of climatic conditions and thus creating many different landscapes, including semi-desert, juniper woodland, deciduous forest, mountain steppe, and a sub-alpine zone. Much of the terrain is steep, often containing rocky outcrops (Aghababyan *et al.* 2015). Among such a variety of landscapes, the Chukar *Alectoris chukar* inhabits quite a large range including semi-deserts, juniper woodlands, and arid mountain steppes from 400 to about 2,000 m above sea level (Adamian & Klem 1999). The Chukar is the only *Alectoris* partridge species in Armenia, which is inhabited by the subspecies *A. c. kurdestanica* (Cramp & Perrins 1977, Collar 2019, Christensen 2020). The species is classified as Least Concern in the IUCN Global Red List owing to its extremely large range and apparently stable population trend (BirdLife International 2019). It was, however, considered Near Threatened in Europe because of moderately rapid population declines in its European breeding range (BirdLife International 2015). The latest IUCN European Red List assessment revised it to Least Concern (BirdLife International 2021), and put the Armenian Chukar population at 3,600–5,200 pairs in 2013–2018, down from 5,000–12,000 in 2002–2012 (BirdLife International 2015) and from 6,500–14,000 in 1997–2002 (BirdLife International 2004). These estimates were based on expert opinion rather than systematic surveys.

In Armenia, the species is a game bird for which the hunting season (usually between September and January), daily bag limit (typically two birds per person per day) and number of permits are set annually (Ministry of Nature Protection 2016, 2017, 2018, Ministry of Environment 2019). There is, however, no government monitoring scheme providing a scientific basis for these decisions. In such a situation, it is possible that the number of hunting permits sold could exceed the number that allow hunting to be sustainable.

Separately, within the context of a Europe-wide initiative to monitor bird populations using skilled volunteers, we have regularly and systematically collected data on Chukar abundance across Armenia since 2003. We hereby seek to provide a scientifically rigorous assessment of the species' distribution, population size and trends in Armenia, identify threats, and analyse existing management practices. Such information will provide a basis for future hunting management and be crucial in informing a review of the procedure for issuing shooting permits.

Material and Methods

Chukar data collection

Early Chukar observations in Armenia recorded in the literature were collated and summarized in Adamian and Klem (1999). Systematic data collection on the Chukar started in 2003 using volunteer birdwatchers and professional ornithologists. The standard European

Monitoring Grid with a 10×10 km mesh was applied to Armenia, dividing the territory of the republic into 374 squares. The counted squares were of two kinds: "systematic" ones that, once counting started on them, were systematically counted every subsequent year, and "opportunistic" ones, where counts were carried out when the opportunity arose. In total, in the period of 2003–2019, 325 squares were visited at least once during that period, including 147 squares with systematic data collection *(Figure 1)*. The remaining 49 squares were not visited because four covered the waters of Lake Sevan, and the other 45 overlapped the country's international border in militarily sensitive areas with restricted access; such squares covered an Armenian land area of 162 km^2, representing only 0.5% of the total area of Armenia. The surveyed squares relevant to Chukar are summarized in *Table 1*. The initial survey in 2003 comprised 38 systematic and 16 opportunistic squares; by 2019,

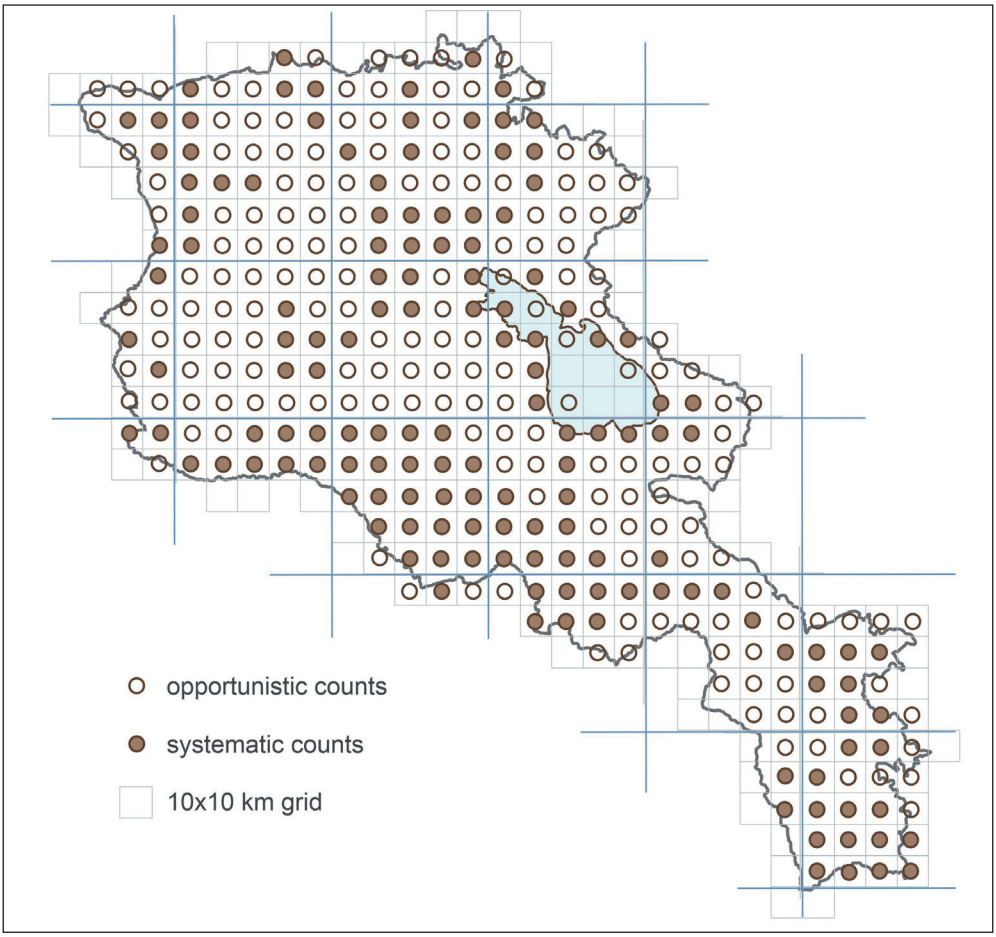

Figure 1. Squares (on a 10×10-km grid) surveyed for Chukars in Armenia either systematically (annually after first count) or opportunistically (at least in one year) over the period 2003–2019.

1. ábra A 2003–2019-es időszakban szisztematikusan (évente az első számlálás után) vagy opportunista módon (legalább egy éven belül) örményországi csukárokra felmért négyzetek (10×10 km-es négyzetekben)

Table 1. Number and type of squares surveyed in Armenia each year in the period 2003–2019, according to whether or not Chukars were recorded

1. táblázat A felmért négyzetek száma és típusa Örményországban 2003–2019 között

Survey type	Chukars recorded	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Systematic	Yes	38	38	38	41	41	45	45	45	45	45	51	58	59	59	59	59	59
Systematic	No	34	34	34	40	40	46	46	46	46	46	48	48	54	54	54	54	54
Opportunistic	Yes	16	14	18	17	20	23	25	28	26	22	24	32	38	41	41	39	41
Opportunistic	No	20	18	17	21	30	32	22	29	33	30	25	36	45	42	51	32	38
Total surveyed		54	52	56	58	61	68	70	73	71	67	75	90	97	100	100	98	100

21 of the squares surveyed opportunistically in earlier years had been integrated into the systematic component, and a further 41 squares had been surveyed opportunistically, giving 100 squares surveyed in total.

In each square, data on Chukars were obtained from two different sources: (1) incidental observations and (2) standardized counts (data collected according to standard methodology). Both types of data may be used to create species distribution maps, and data collected by the second method may be used for estimating population densities and trends.

1. Incidental observations were provided by birdwatchers and accepted as long as they conformed to minimum data requirements: accurate species identification, observation date, geographical coordinates, name of nearest locality (human settlement, mountain, historical site, etc.), breeding code (based on the bird's behaviour, indicating how likely the bird is breeding in the surveyed area – Voříšek *et al.* 2008), observer name and contact details. The observations often have additional information, e.g. time, observation duration, number of people in the group, etc. Since it was not always possible to record the precise geographical coordinates on the spot, the information was sometimes provided at the level of the 10×10-km square. Most of the data was accumulated in the platform Observation.org, however, data from iNaturalist, eBird, and GBIF were also considered in cases where the identification of the species was supported by photos or voice recordings.

2. Standardized spring counts (counts done following a predefined standard protocol) can be conducted by both ornithologists and skilled birdwatchers. Counts were carried out during a fixed period of 1 or 2 hours, when an observer slowly walked along a transect route counting all the birds within 100 m either side of the transect (hence in a strip 200 m wide). As far as possible, surveys were done at the time of the day when birds were most active (as a rule, early morning) in favorable weather conditions, such as absence of rain and weak wind (below Beaufort Force 3). The best season for Chukar counts was considered to be the period between 1 April and 20 May. Nevertheless, data collected in March and in June were used as well. The standardized counts required more detailed data collection than incidental observations: number of individuals observed or heard, observation date, geographical coordinates of the beginning and end of the route, type of habitat (semi-desert, juniper woodland, mountain steppe, lower subalpine zone, semi-urban), start and end times of the count, individual-specific breeding codes, observer name and contact details. The number of routes in one 10×10 km square varied from one

to three, depending on how many habitat types were present in a square. Each route was dedicated to one type of habitat only. We tried to keep the same routes for the standardized counts and to survey them every year, whenever possible. However, in the period 2013–2017, when the number of volunteer counters increased thanks to the fieldwork required for the European Breeding Bird Atlas 2 (Zbiden *et al.* 2020), many new standardized counts were created from atlas routes. All data were collated at the end of each counting season, entered into a database and checked.

Hunting data collection

To gather information on hunting pressure on the Chukar, we conducted surveys of the heads of seven Hunters' Unions and their hunter members (keeping the hunters' survey confidential to reduce the risk of false reporting). We tried to keep the numbers per Hunters' Union roughly equal (maximum difference was 10 hunters). The survey was conducted in spring 2019, after the end of the 2018–2019 hunting season, by sending out over 800 questionnaires to randomly selected hunters. A total of 486 responses were received to the mailing, and a further 14 responses obtained following personal requests, giving a total of 500. The following questions were included in the questionnaire: (1) Do you hunt? (2) Do you ever hunt Chukar? (3) How often do you hunt Chukar (almost every year; not frequently; rarely)? (4) How many Chukars do you hunt annually? As the Chukar is the only *Alectoris* species in Armenia, and the only other partridge species is the very different Grey Partridge *Perdix perdix*, there was little risk of hunters confusing Chukars with another species.

We also interviewed staff at the State Inspectorate for Nature Protection and Mineral Resources. These interviews were conducted with eight inspectors from Ararat, Armavir, Vayots Dzor, and Syunik Provinces and were less structured. The main questions that were relevant here were related to the ability of the inspectors to monitor the number of shot birds, to detect poaching outside the legal hunting season, and to detect poaching in protected areas.

Data analysis

Chukar distributional range was determined at the 10×10-km square level. A given square was deemed occupied if the species had been recorded in any one of the 17 years 2003–2019 through incidental observation or standardized count. To compare the change in distribution from before 2003 with that during 2003–2017, we also digitized all the previous records summarized in Adamian and Klem (1999). Mapping was implemented using the software package ArcGIS 10.0 (Environmental Systems Research Institute, Inc.).

Chukar density was estimated for each transect route by dividing the recorded number by the area surveyed, obtained as the transect length multiplied by the strip width of 200 m (Bart 2005). With a single distance band within which birds were recorded, we were unable to correct for detectability, so the density estimates that we obtained were minimum estimates. The density values were then averaged across transects, overall

and by habitat type. We compared the rates of change between habitats using analysis of covariance applied to log-transformed density, using year as covariate and habitat as factor. The total size of the Armenian Chukar breeding population (pairs) in each of the years 2003–2019 was estimated using post-stratification by habitat type (Lehtonen & Pahkinen 2004): it was calculated as half of the sum of the number estimated in each habitat type, obtained by multiplying the habitat-specific density by the area of habitat within the occupied range. The annual estimates were averaged over the periods 2003–2012 and 2013–2018 for comparison with BirdLife International (2015, 2021) values. For the most recent estimates in 2018 and 2019, we calculated 95% confidence limits as total size ± 1.96 SE, where SE (standard error) was the square root of the sum of the squared SEs of the habitat-specific numbers, themselves obtained by multiplying the SE of the habitat-specific densities by the habitat-specific areas. A similar calculation, restricted to the public hunting lands within the occupied range, provided estimates of the number of Chukar pairs on public hunting lands. The same was done for non-hunted lands. In the absence of data on the age of hunted birds, the number of Chukars present in the autumn was approximated as three times the number of pairs, using a standard approach from French hunters based on the average ratio of young birds to adult females for the closely related Red-legged Partridge (Pasquet 2006). The approximation was carried out for 2018 (corresponding to the start of the 2018/2019 hunting season, which was the season before the hunter survey and hence most suitable for comparison with the hunting bag estimated from the survey) and 2019 (for comparison with the number of 2019 hunting licenses).

To calculate population trends, we used transects with multi-year data series and processed the data (density values per transect and year) using TRIM 3.54 software (Van Strien *et al.* 2004). In total, there were 1,062 data values analysed, and their number increased from 44 in 2003 to 82 starting from 2015, resulting in 332 missing counts in the whole period 2003–2019. We calculated a population index using log-linear Poisson regression, and applying a time effect model; the indices are calculated relative to 2003, which is given a value of 100. TRIM also provides an estimate of overall trend in the form of the average annual rate of change r and its standard error $SE(r)$ across the full span of years (Pannekoek & van Strien 2005). To assess the importance of the trend, van Strien *et al.* (2001) recommended considering both its magnitude and statistical significance according to five categories: substantial decline or increase (confidence interval lies below -20% or above 20% respectively in a 20-year period), non-substantial decline or increase (confidence interval lies above -20% or below 20% respectively and excludes zero), decline or increase (confidence interval includes -20% or 20% respectively and excludes zero), stable (confidence interval lies above -20%, below 20% and includes zero) and poorly known (confidence interval includes both zero and one or both of -20% and 20%). The annual rate of change was converted to a 20-year change ρ by calculating $\rho = r^{19}$, with standard error $SE(\rho) = SE(r)\ (19\ r^{18})$ and 95% confidence interval $\rho \pm 1.96\ SE(\rho)$ (Hensler 1985, van Strien *et al.* 2001).

Results

Chukar distribution, population size and trend in Armenia

During the surveys of 2003–2019, the Chukar was recorded in relatively large areas of the Central, Southern, South-eastern and North-eastern regions of the country *(Figure 2)*. The species was recorded at elevations ranging from 400 to 2,500 m above sea level. The habitats occupied by Chukar included semi-deserts (1,684 km^2), juniper woodlands (1,065 km^2), mountain steppes (2,233 km^2), lower parts of the subalpine zone (100 km^2), and semi-urban areas (124 km^2). Its presence was typically associated with rocky slopes and cliff formations *(Figure 3)*. The total area occupied by Chukars in Armenia is estimated at 5,206 km^2, representing 17% of the country.

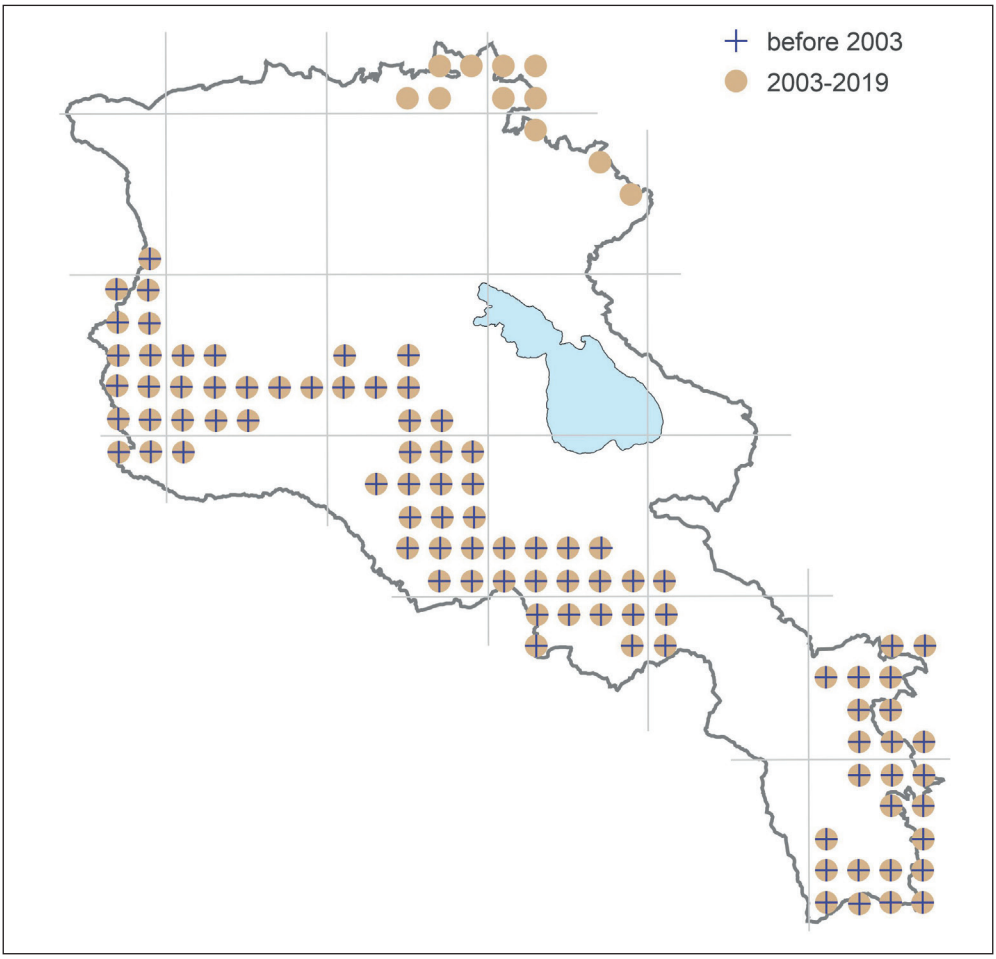

Figure 2. Distribution of the Chukar in Armenia based on a 10×10-km square grid, before and after 2003
2. ábra A csukárok elosztása Örményországban 10x10 km-es négyzetekben, 2003 előtt és után

Figure 3. Typical habitat of the Chukar in the Urts mountains of Armenia (Photo by K. Aghababyan)
3. ábra A csukár tipikus élőhelye Örményország Urts-hegységében (Fotó: K. Aghababyan)

The average density of the species during 2003–2019 varied by habitat, being highest in juniper woodlands and the upper zone of semi-deserts *(Table 2)*. However, the average rate of change in density over time differed between habitat types ($F_{4,60} = 6.11$, $P < 0.001$). In juniper woodlands, the rate did not differ significantly from zero (-1.06%, SE = 1.12, $t_{15} = 0.95$, $P = 0.358$); it was negative in mountain steppes (-2.76%, SE = 0.95, $t_{15} = 2.86$, $P = 0.012$) and semi-deserts (-3.22%, SE = 1.04, $t_{15} = 3.05$, $P = 0.008$), and increased in the lower subalpine zone (3.07%, SE = 0.88, $t_{15} = 3.54$, $P = 0.003$). For the BirdLife International (2015) period 2002–2012, we estimated an average breeding population size of 20,077 pairs (range 13,816–26,119). For the BirdLife International (2021) period 2013–2018, the estimate was 17,278 pairs (range 14,530–20,823). For 2019, the size of the Armenian Chukar breeding population was estimated at 12,472 pairs (95% confidence limits 10,266 to 14,677 pairs).

The TRIM model fitted well (goodness of fit: $\chi^2 = 679.19$, df = 1296, $P > 0.999$). From 2003 to 2019, the average annual change in the population index calculated by TRIM was -1.41% (*SE* = 0.24), significantly different from zero ($z = 5.88$, $P < 0.001$). Over 20 years, this equates to a 23.6% decrease (confidence interval -30.6 to -16.7%), qualifying as a decline *(Figure 4)*. The trend shows strong fluctuations over time *(Figure 4)*.

Table 2. Average breeding density (birds/km2) of the Chukar in Armenia in five different habitat types, and estimated breeding population size (pairs). NA = Not available

2. táblázat A csukár átlagos fészkelési denzitása (egyed/ km2) és becsült populáció nagysága öt különböző élőhelytípusban Örményországban

Year	Average breeding density per habitat type										Breeding population size
	Juniper woodland (1,065 km²)		Lower subalpine zone (100 km²)		Mountain steppe (2,233 km²)		Semi-desert (1,684 km²)		Semi-urban areas (124 km²)		Total counts	½ sum across habitats of density x area
	Average	(n)	Average	(n)	Average	(n)	Average	(n)	Average	(n)		Total pairs
2003	13.93	11	3.11	9	7.69	11	11.83	13	NA	0	44	26,119
2004	13.10	11	2.84	9	7.04	11	10.29	13	NA	0	44	23,635
2005	14.27	11	3.11	9	6.94	11	12.07	13	NA	0	44	25,670
2006	12.60	12	3.89	10	4.81	13	7.19	13	NA	0	48	18,334
2007	8.93	12	3.50	10	5.56	13	6.00	13	NA	0	48	16,187
2008	7.93	13	3.63	13	4.35	15	5.40	15	NA	0	56	13,816
2009	8.60	13	3.76	13	4.44	15	6.24	15	NA	0	56	14,982
2010	10.27	13	4.29	13	5.37	15	6.95	15	NA	0	56	17,531
2011	15.27	13	5.08	13	5.83	15	8.02	15	NA	0	56	21,652
2012	12.10	13	5.34	13	7.50	15	9.21	15	NA	0	56	22,843
2013	14.43	15	5.08	16	5.46	19	7.55	18	NA	0	68	20,394
2014	12.10	15	4.95	17	6.02	24	7.55	20	NA	0	76	19,765
2015	15.27	15	6.66	19	5.65	27	7.19	21	NA	0	82	20,823
2016	11.10	15	4.68	19	3.98	27	6.12	21	NA	0	82	15,743
2017	7.93	15	3.63	19	4.72	27	5.76	21	NA	0	82	14,530
2018	10.93	15	4.42	19	4.72	27	6.83	21	2.50	5	87	17,217
2019	8.93	15	4.55	19	3.15	27	4.57	21	2.00	5	87	12,472
Average across years ± *SD*	**11.63±2.55 (*n*=17 years)**		**4.27±0.98 (*n*=17 years)**		**5.48±1.27 (*n*=17 years)**		**7.58±2.14 (*n*=17 years)**		**2.25±0.35 (*n*=2 years)**			**18,924±4,139 (*n*=17 years)**

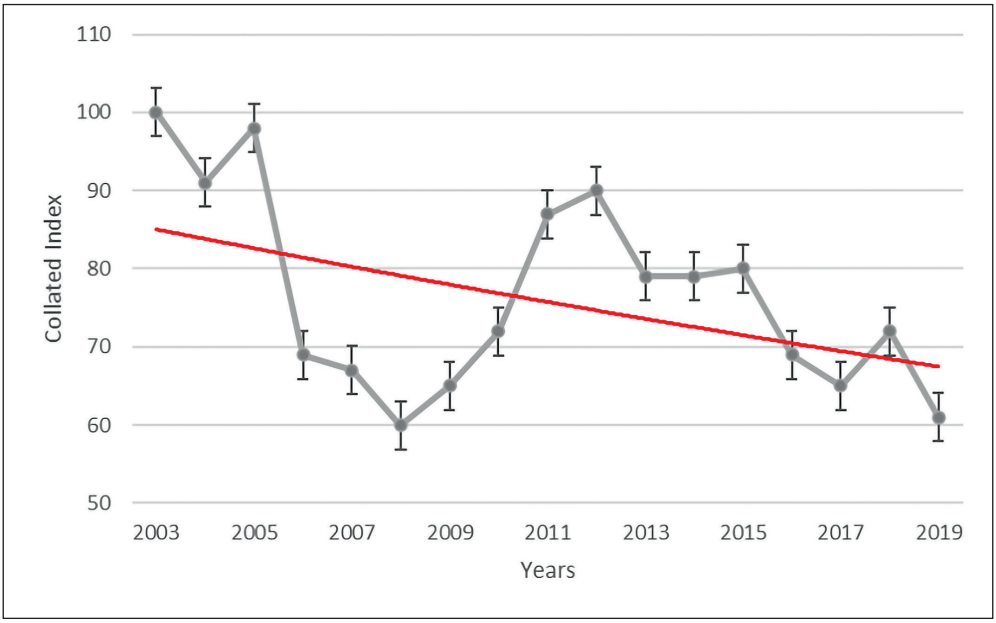

Figure 4. Annual TRIM index (relative to 2003, which is standardized to 100) of Chukar abundance in Armenia during 2003–2019.The black line is the best-fitting curve with a constant rate of change of -1.41% (*SE* = 0.24) per annum

4. ábra A csukár abundanciájának éves TRIM indexe (2003-hoz viszonyítva, amely 100-ra van szabványosítva) Örményországban 2003–2019 között. A fekete vonal az évi változási rátát mutatja (-1,41%, SE = 0,24)

Chukars on hunted and non-hunted areas

In Armenia, Chukars are present on 20 public hunting lands with a total area of 2,414 km^2. Based on areas within them of semi-desert (1,052 km^2), juniper woodland (80 km^2), mountain steppe (1,254 km^2), and subalpine habitats (28 km^2), the total number of breeding pairs of the species within the public hunting lands is estimated at 8,213 (95% confidence limits 6,082 to 10,343) in 2018 *(Table 3)*. Likewise, the total number of breeding Chukar pairs on non-hunted lands in 2018 is estimated at 9,444 (95% confidence limits 7,664–11,224) *(Table 3)*.

Despite apparent differences in density within habitats between hunted and non-hunted areas *(Table 3)*, there was no detectable interaction between habitat and hunted status ($F_{3,78}$ = 1.25, P = 0.297), and no significant difference in overall density between hunted and non-hunted areas in 2018 ($F_{1,85}$ = 0.03, P = 0.870) or 2019 ($F_{1,85}$ = 0.29, P = 0.591).

Over the period 2003–2019, the average annual rate of change in overall Chukar density on hunted areas was negative (-3.44%, SE = 0.77, t_{15} = 4.47, P < 0.001). On non-hunted areas, it did not differ significantly from zero (-1.00%, SE = 0.89, t_{15} = 1.12, P = 0.280). The two rates differed significantly ($F_{1,30}$ = 4.30, P = 0.047). In order to 2018 and 2019 densities to be similar on hunted and non-hunted areas, the starting density on hunted areas needed to be higher than on non-hunted ones, and in fact in the first three years (2003–2005) density averaged 10.74 on hunted areas versus 7.99 on non-hunted areas.

Table 3. Habitat areas, habitat-specific Chukar densities (birds/km^2 ± 1 SE), number of counts (in parentheses) and estimated population sizes (pairs, 95% confidence interval in brackets) in hunted and non-hunted parts of the Chukar range in Armenia in 2018 and 2019

3. táblázat A csukár élőhelyek területnagyságai, az élőhely-specifikus egyedűrűség (madár/km^2 ± SE), a felmérések száma (zárójelben) és becsült a populációméretek (párok, zárójelben 95%-os konfidencia intervallum) az örményországi elterjedési terület vadászott és nem vadászott részein 2018-ban és 2019-ben

Hunting status		Juniper woodland	Lower subalpine zone	Mountain steppe	Semi-desert	Semi-urban areas	Overall	Population size (pairs)
Hunted	Area (km^2)	80	28	1254	1052	0	2414	
	Density 2018	7.50±0.00 (1)	5.00±0.00 (1)	5.00±0.62 (12)	8.95±1.93 (11)	NA	6.80±0.90	8,213 (6,082-10,343)
	Density 2019	10.00±0.00 (1)	2.50±0.00 (1)	3.33±0.56 (12)	5.77±1.72 (11)	NA	4.60±0.80	5,558 (3,656-7,460)
Not hunted	Area (km^2)	985	72	979	632	124	2792	
	Density 2018	11.18±1.71 (14)	4.39±0.43 (18)	4.50±0.50 (15)	4.50±0.73 (10)	2.50±0.79 (5)	6.77±0.65	9,444 (7,664-11,224)
	Density 2019	8.86±1.17 (14)	4.67±0.45 (18)	3.00±0.75 (15)	3.25±0.75 (10)	2.00±0.94 (5)	5.12±0.52	7,151 (5,729-8,574)
Overall	Area (km^2)	1065	100	2233	1684	124	5206	
	Density 2018	10.93±1.61 (15)	4.42±0.41 (19)	4.72±0.39 (27)	6.83±1.16 (21)	2.50±0.79 (5)	6.61±0.53	17,217 (14,528-19,905)
	Density 2019	8.93±1.09 (15)	4.55±0.44 (19)	3.15±0.43 (27)	4.57±0.99 (21)	2.00±0.94 (5)	4.79±0.43	12,472 (10,266-14,677)

Chukar hunting management

According to the seven Hunters' Unions of Armenia, there are over 50,000 hunters in the country. However, the number of active hunters is reckoned by the Hunters' Unions to lie between 10,000 and 20,000 people. The number of hunting permits issued annually (one permit per Chukar allowed to be shot) increased ten-fold between 2016 and 2019 *(Table 4)*. The table also shows that survey data was used for decision making only in 2017 for the hunting season 2017–2018.

Out of the 500 hunters surveyed in 2019, 146 (29%) of them responded that they hunt Chukar annually. Among those 146 hunters, the number of Chukars shot per person per annum varied from 1 to 15, with an average (± SD) of 5.88±3.05 birds. Extrapolation of that number to a total of 10,000 active hunters, of which 2,900 shoot Chukars, results in an estimated 17,052 Chukars shot per year (95% confidence limits 14,342–19,762), while in case of 20,000 active hunters, the estimate is 34,104 (95% confidence limits 28,685–39,523) Chukars shot per year. These compare with a rough population estimate of 24,639 (95% confidence limits 18,246–31,029) Chukars present in hunted areas in autumn 2018, implying a harvest rate between 46% and 100%. The 19,534 Chukar hunting permits issued in 2018 *(Table 4)* represented 79% of the autumn population size. The number of 30,006 permits issued in 2019 was nearly double an estimated 2019 autumn population size in hunted areas of 16,674 birds.

Interviews with the heads of seven Hunters' Unions established that the hunters obtain hunting permits based on two recommendations from existing hunters and a face-to-face interview. The questions asked at the interview cover weapon safety but do not assess knowledge on game bird species identification, which public lands are open to hunting, which species are Red-listed, which hunting methods are allowed and which ones prohibited, daily bag limits, cases of poaching and the punishments meted out for infractions.

Table 4. Hunting permits issued for Chukar in the hunting seasons of 2016–2019 in Armenia. NA = Not available

4. táblázat Az Örményországban csukárra kiadott vadászati engedélyek száma a 2016–2019-es vadászati szezonban. (NA = nincs adat)

Hunting season	Number of hunting permits for Chukar	Count of adult Chukar individuals in public hunting lands	Year of count	Comments
2016-2017	3,040	NA		Number of permits fixed without a population count
2017-2018	2,860	27,610	2017	Count data provided by TSE NGO, used to determine number of permits
2018-2019	19,534	NA		Same count data used as in 2017, calculation method is unknown
2019-2020	30,006	NA		Number of permits fixed without considering the 2017 count

The interview with the State Inspectorate body established that during the last four years there were over 100 cases of poaching of Chukars, defined as hunting during the closed season or away from public hunting lands. In the same period the Inspectorate stated that there were no recorded cases of hunters exceeding daily bag limits. However, the Inspectorate pointed out that the absence of such records is probably because the number of inspections is very low, owing to understaffing within the Inspectorate body and a lack of financial resources allocated for the inspection process. The Inspectorate also noted an absence of cooperation between the Inspectorate and the Hunters' Unions, in contrast to the situation that prevailed in Soviet times (before independence in 1991), when such cooperation was very efficient and hunters volunteered for the inspection process, keeping poaching at a low level.

Discussion

Chukar population status

Adamian and Klem (1999) summarise the historical distribution of the Chukar in Armenia, and state that the species is found in the Central and Southern regions. It does not mention the elevation range, but does note that it inhabits semi-deserts, juniper thickets, and arid mountain steppes. By comparison with the results of our surveys, it therefore appears that since 1995 the Chukar has expanded its latitudinal distribution, occupying the north-eastern regions of the country, as well as its vertical range as it has colonised the lower subalpine zone. Such an altitudinal shift may be related to climate change, which has been documented in Armenia (Ministry of Nature Protection 2015).

Our estimate of 20,077 pairs (range 13,816–26,119) for 2013–2018 is more than twice as high as the BirdLife International (2015) estimate of 5,000–12,000 pairs. Likewise, our estimate of 17,278 pairs (range 14,530–20,823)) for 2013–2018 is four times higher than the BirdLife International (2021) estimate of 3,600–5,200 pairs. This is good news for the status of the Chukar in Armenia as it is more abundant than previously believed. The fluctuations in annual Chukar abundance that we have observed could be related to several possible reasons: variations in hunting pressure (Besnard *et al.* 2010, Mustin *et al.* 2011), outbreaks of disease, such as the ones detected in Red-Legged Partridge *Alectoris rufa* (Millán 2009), weather (Guzmán *et al.* 2020) and changes in food availability for adults or young (e.g. Norman 2008, Potts 2012). Our results suggest indirectly that hunting pressure may be influencing density in that in the two habitat zones that are predominantly non-hunted, juniper woodlands (8% hunted from *Table 3*) and the lower subalpine zone (28% hunted), the average annual rate of change over 2003–2019 either does not differ significantly from zero or is increasing, whereas significant declines were observed for mountain steppe (56% hunted) and semi-desert (62% hunted). At the level of the whole country, the long-term average annual population change of -1.4% per annum has resulted as classifying the trend as a decline.

The conservation status of the Chukar was not evaluated for the latest edition of the Red Book of Animals of Armenia, as it was considered a common game bird (Aghasyan &

Kalashyan 2010). Under IUCN Red List guidelines, the time period over which to assess population change is three generation lengths, which in the case of the Chukar is 11.7 years (from the BirdLife global assessments at http://datazone.birdlife.org). This translates into a decline of 14%, well below the threshold of 30% needed to qualify under Red List criterion Taking into consideration its distributional range and population size, the species does not meet the requirements under Red List criteria B, C or D and should be considered as Least Concern (IUCN Standards and Petitions Committee 2019) in Armenia. Nevertheless, the slow long-term population decline should be viewed as a warning signal, indicating the need for continued monitoring and precautionary measures.

Hunting management

Many of the possible causes of the long-term decline of the Chukar population are ones linked to fluctuations in the natural environment, which are difficult to counteract. However, hunting is a human activity under state control, so this is one area where it is possible to ensure sustainability by improving the way in which hunting is managed. Our data imply a harvest rate in 2018 between 46% and 100%, which is unsustainably high. We draw attention to several management issues that are currently deficient and need to be addressed. First, the lack of game bird monitoring, which leads to uninformed decision-making when deciding how many individual birds may be hunted each year. This is mostly the result of a lack of targeted financial resources and a lack of cooperation between the Ministry of Environment, the Hunters' Unions and the NGOs which are able to organize volunteer-based bird monitoring. Second, there are few checks in the field on the number of shot specimens, meaning that hunters are able to shoot more birds than is decreed in their hunting permits without being caught. Again, the causes are a lack of finances and inadequate cooperation with the Hunters' Unions. In turn, the lack of financial resources exists mainly because the prices paid for the hunting permits are not directly targeted at species monitoring and in-field hunting inspections. Instead, the Department for licenses, permits and compliances (responsible for monitoring) and the State Inspectorate Body (responsible for control) receive an annual budget from the State, which is not enough for proper implementation of game bird monitoring and hunting inspections (State Inspectorate, personal communication).

It could be thought that an alternative to the hunting of wild Chukars is the establishment of game farms where the indigenous Chukars are bred in captivity and, starting from the second generation, are released for shooting. Currently, Armenian law significantly complicates obtaining the necessary licenses for such business ("Zinvors" Hunters' Union, personal communication). In fact, this is likely to be a blessing in disguise, because there are many reports of negative effects of released game birds on wild populations (e.g. reviews in Sokos *et al.* 2008, Mustin *et al.* 2011). Releasing reared Chukars for shooting in Armenia will inevitably increase the hunting pressure on wild Chukars (cf. Potts 1986, Watson *et al.* 2007, Sokos *et al.* 2008, Mustin *et al.* 2011), as well as increasing the risks to wild birds of disease transmission and genetic contamination by increasingly domesticated and maladapted captive-bred birds of potentially dubious genetic stock (Blanco-Aguilar *et al.*

2008, Barbanera *et al.* 2009, 2010, Mustin *et al.* 2011). Moreover, hunters themselves rate wild birds much more highly as quarry than released captive-reared birds (e.g. Delibes-Mateos *et al.* 2014).

Recommendations

As part of a programme to halt the decline in the Armenian Chukar population, we recommend starting with improving the management and control of hunting. In particular, we suggest the following: (1) set up annual monitoring of the Chukar on public hunting lands (along with other game bird species), which should include counts of adult birds and their offspring; (2) develop a mechanism to base decisions concerning the annual number of hunting permits on the monitoring data; (3) develop alternative mechanisms for allocating the funds which are generated from the sale of hunting permits, targeting the revenue towards monitoring the populations of the Chukar and other game species, and towards better control of hunting and poaching on the ground; (4) develop a new State exam for obtaining a hunting licence aimed at having better educated and more responsible hunters; (5) strengthen the current legislation that makes it difficult to allow the releasing of captive-bred Chukars for shooting; (6) consider implementing winter feeding of Chukars (and probably other game birds) on public hunting lands to decrease their mortality during harsh winters. Further elements of the programme should be to study the reasons for annual changes in breeding success, and find out more about the epidemiology of Chukar diseases to better understand the causes of the short-term population fluctuations.

Acknowledgements

The monitoring of the species in Armenia is supported by members of the Armenian Birdwatching Association. Data archiving is supported by the Observation Foundation. During 2015–2017 the survey was also supported financially by the European Bird Census Council (EBCC) through a grant from the MAVA Foundation for the European Breeding Bird Atlas EBBA2. The Environmental Programme of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH contributed financially to the data analysis. Administrative support during this work was provided by the Ministry of Environment of the Republic of Armenia.

References

Adamian, M. & Klem, D. 1999. Handbook of the Birds of Armenia. – American University of Armenia, California

Aghasyan, A. & Kalashyan, M. (eds.) 2010. The Red Book of Animals of the Republic of Armenia. – Ministry of Nature Protection, Yerevan

Aghababyan, K. E., Ter-Voskanyan, H., Tumanyan, S. & Khachatryan, A. 2015. First National Atlas of the Birds of Armenia. – Bird Census News 28(2): 52–58.

Barbanera, F., Guerrini, M., Khan, A. A., Panayides, P., Hadjigerou, P., Sokos, C. K., Gombobaatar, S., Samadi, S., Khan, B. Y., Tofanelli, S., Paoli, G. & Dini, F. 2009. Human-mediated introgression of exotic Chukar (*Alectoris chukar*, Galliformes) genes from East Asia into native Mediterranean partridges. – Biological Invasions 11: 333–348. DOI: 10.1007/s10530-008-9251-0

Barbanera, F., Pergams, O. R. W., Guerrini, M., Forcina, G., Panayides, P. & Dini, F. 2010. Genetic consequences of intensive management in gamebirds. – Biological Conservation 143: 1259–1268. DOI: 10.1016/j.biocon.2010.02.035

Bart, J. 2005. Estimating Total Population Size for Songbirds. – USDA Forest Service Generated Technical Report PSW-GTR-191, pp. 770–780.

Besnard, A., Novoa, C. & Gimenez, O. 2010. Hunting impact on the population dynamics of Pyrenean Grey Partridge *Perdix perdix hispaniensis*. – Wildlife Biology 16(2): 135–143. DOI: 10.2981/08-077

BirdLife International 2015. *Alectoris chukar*. – The IUCN Red List of Threatened Species 2015: e.T22678691A59941068 (scope: Europe)

BirdLife International 2019. *Alectoris chukar* (amended version of 2018 assessment). –The IUCN Red List of Threatened Species 2019: e.T22678691A155454429. DOI: 10.2305/IUCN.UK.2019-3.RLTS.T22678691A155454429.en.

Blanco-Aguiar, J. A., González-Jara, P., Ferrero, M. E., Sánchez-Barbudo, I., Virgós, E., Villafuerte, R. & Dávila, J. A. 2008. Assessment of game restocking contributions to anthropogenic hybridization: the case of the Iberian Red-legged Partridge. – Animal Conservation 11: 535–545.

Cramp, S. & Perrins, C. M. 1977. Handbook of the Birds of Europe, the Middle East and Africa. The birds of the western Palearctic, Vol. 1. Ostrich to Ducks. – Oxford University Press, Oxford, pp. 288–301.

Christensen, G. C. 2020. Chukar *(Alectoris chukar)*, version 1.0. – In: Poole, A. F. & Gill, F. B. (eds.) Birds of the World. – Cornell Lab of Ornithology, Ithaca, NY, USA. DOI: 10.2173/bow.chukar.01

Delibes-Mateos, M., Giergiczny, M., Caro, J., Viñuela, J., Riera, P. & Arroyo, B. 2014. Does hunters' willingness to pay match the best hunting options for biodiversity conservation? A choice experiment application for small-game hunting in Spain. – Biological Conservation 177: 36–42.

Guzmán, J. L., Viñuela, J., Carranza, J., Porras, T. J. & Arroyo, B. 2020. Red-legged Partridge *Alectoris rufa* productivity in relation to weather, land use, and releases of farm-reared birds. – European Journal of Wildlife Research 66, article no. 87. DOI: 10.1007/s10344-020-01394-x.

Hensler, G. L. 1985. Estimation and comparison of functions of daily nest survival probabilities using the Mayfield method. – In: Morgan, B. J. T. & North, P. M. (eds.) Statistics in Ornithology. Lecture Notes in Statistics. No. 29: 289–301. Springer-Verlag, Berlin

IUCN Standards and Petitions Committee 2019. Guidelines for Using the IUCN Red List Categories and Criteria. Version 14. – Prepared by the Standards and Petitions Committee

Lehtonen, R. & Pahkinen, E. 2004. Practical Methods for Design and Analysis of Complex Surveys. – John Wiley, Chichester

Millán, J. 2009. Diseases of the Red-Legged Partridge (*Alectoris rufa* L.): a review. – Wildlife Biology in Practice 5(1): 70–88.

Ministry of Nature Protection 2015. Armenia's Third National Communication on Climate Change. – Lusabats Publishing House, Yerevan

Ministry of Nature Protection 2016. Hayastani Hanrapetutyan taratsqum vorsi kendanineri 2016–2017 tvakanneri siroghakan vorsi hamar tuilatreli chapaqanaknery ev vrants zhamketnery sahmanelu masin [Decree on the number of game-animal shooting permits and the period of hunting in the territory of the Republic of Armenia in 2016–2017]. – Ministry of Nature Protection, Decree No 201-A, 17.08.2016. (in Armenian)

Ministry of Nature Protection 2017. Hayastani Hanrapetutyan taratsqum vorsi kendanineri 2017–2018 tvakanneri siroghakan vorsi hamar tuilatreli chapaqanaknery ev vrants zhamketnery sahmanelu masin [Decree on the number of game-animal shooting permits and the period of hunting in the territory of the Republic of Armenia in 2017–2018]. – Ministry of Nature Protection, Decree No 254-N, 01.08.2017. (in Armenian)

Ministry of Nature Protection 2018. Hayastani Hanrapetutyan taratsqum vorsi kendanineri 2018–2019 tvakanneri siroghakan vorsi hamar tuilatreli chapaqanaknery ev vrants zhamketnery sahmanelu masin [Decree on the number of game-animal shooting permits and the period of hunting in the territory of the Republic of Armenia in 2018–2019]. – Ministry of Nature Protection, Decree No 229-N, 31.07.2018. (in Armenian)

Ministry of Environment 2019. Hayastani Hanrapetutyan taratsqum vorsi kendanineri 2019–2020 tvakanneri siroghakan vorsi hamar tuilatreli chapaqanaknery ev vrants zhamketnery sahmanelu masin [Decree on the number of game-animal shooting permits and the period of hunting in the territory of the Republic of Armenia in 2019–2020]. – Ministry of Environment, Decree No 279-N, 20.08.2019. (in Armenian)

Mustin, K., Newey, S., Irvine, J., Arroyo, B. & Redpath, S. 2011. Biodiversity impacts of game bird hunting and associated management practices in Europe and North America. – Contract Report, James Hutton Institute

Norman, D. 2008. Birds in Cheshire and Wirral: a breeding and wintering atlas. – Cheshire and Wirral Ornithological Society

Pannekoek, J. & van Strien, A. J. 2005. TRIM 3 Manual (Trends and Indices for Monitoring data). – Statistics Netherlands. Retrieved from https://www.ebcc.info/art-13/ on 16th of Dec 2019.

Pasquet, G. 2006. Le Petit Gibier: Conservation des Espèces, Aménagement des Milieux [Small Game: Species Conservation, Habitat Management]. – Editions du Gerfaut, Aix-en-Provence

Potts, G. R. 1986. The Partridge: Pesticides, Predation and Conservation. – Collins, London

Potts, G. R. 2012. The Partridge: Countryside Barometer. – Collins, London

Sokos, C. K., Birtsas, P. K. & Tsachalidis, E. P. 2008. The aims of galliforms release and choice of techniques. – Wildlife Biology 14: 412–422.

van Strien, A. J., Pannekoek, J. & Gibbons, D. W. 2001. Indexing European bird population trends using results of national monitoring schemes: a trial of a new method. – Bird Study 48(2): 200–213. DOI: 10.1080/00063650109461219

van Strien, A. J., Pannekoek, J., Hagelmeijer, E. J. M. & Verstrael, T. J. 2004. A loglinear Poisson regression method to analyse bird monitoring data. – In: Anselin, A. (ed.) Bird Numbers 1995. Proceedings of the International Conference and 13th Meeting of the European Bird Census Council, Pärnu, Estonia. – Bird Census News 13(2000): 33–39.

Voříšek, P., Klvaňová, A., Wotton, S. & Gregory, R. D. 2008. A best practice guide for wild bird monitoring schemes. First ed. – RSPB/CSO

Watson, M., Aebischer, N. J., Potts, G. R., Ewald, J. A. 2007. The relative effects of raptor predation and shooting on overwinter mortality of grey partridges in the United Kingdom. – Journal of Applied Ecology 44: 972–982.

Zbiden, N., Sinav, L. & Magnin, G. 2020. *Alectoris chukar* – Chukar. – In: Keller, V., Herrando, S., Voříšek, P., Franch, M., Kipson, M., Milanesi, P., Martí, D., Anton, M., Klvanová, A., Kalyakin, M. V., Bauer, H-G. & Foppen, R. P. B. (eds.) European Breeding Bird Atlas 2: Distribution, Abundance and Change. – European Birds Census Council and Lynx Editions, Barcelona, pp. 74–75.