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Quantifying the Effects of Poaching on Four Partridge Species in Dera Ismail Khan, Pakistan

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ABSTRACT

Poaching involves killing or trapping partridges for pets, bushmeat, or enjoyment. A large number of partridges are poached each year across the globe. Field surveys and pre-structured questionnaire surveys were performed from March 2022 to December 2023 to quantify species abundance, diversity indices, breeding in captivity, poaching effects, and income generation to understand the poaching effects. In total, 4084 individuals of two species of partridges namely Chakor partridge– *Alectoris chukar* (1204 individuals) and Grey partridges *Ortygornis pondicerianus*– (1528 individuals) and See–see partridge– *Ammoperdix griseogularis* (510 individuals); and two Francolin species (commonly known as partridges) , Black partridges – *Francolinus francolinus* (842 individuals), were detected by point count technique. The partridge monthly frequency and sex ratio varied significantly ($F_{4, 87} = 41.900$, $p < 0.05$ and $F_{4, 11} = 11.300$, $p < 0.05$). The diversity indices, i.e., species diversity index (Gray partridges; D = 20.72; H' = 2.999), species richness (See–see partridges; $R_1 = 3.368$; $R_2 = 0.974$) and species evenness (grey partridge; $E_1 = 0.990$; $E_2 = 0.987$) varied from among the species in the study area. Additionally, 213 respondents were interviewed and information was obtained through questionnaires. The perceptions of the respondents were varied. Various predators, diseases, and activities by humans posed numerous threats to partridges. In captivity, mating occurs between March and May, and egg– laying begins between April and June. Egg frequency, incubation period, hatching rate, chick survival rate, and fledging varied among species. Partridges were prevalently raised for income generating (51.92%), hobby (13.46%), and pet (11.54%) purpose. Approximately Pak. Rs. 18–22 million are generated each year from partridge raising.

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Key words
Poaching, Partridges, Captivity, Ecology, Diversity index, Threats, Gamebird

INTRODUCTION

The partridge is a corpulent, medium-sized, ground-dwelling game bird of the order Galliformes and family Phasianidae (Ali and Ripley, 2002). The global biodiversity of partridges has been estimated at 56 species. Approximately 37 species are considered to be of least concern, and 19 are considered to be threatened or endangered (Fuller *et al*., 2000; National Geographic, 2024). A total of 10 species of partridges are found in Pakistan out of 56 species; the see-see partridge, *Ammoperdix grisecogularis*, the chukar, *Alectoris chukar*, the Tibetan snowcock, *Tetraogallus tibetanus;* the Himalayan snowcock, *Tetraogallus himalayensis*, jungle bush quail, *Perdicula asiatica;* black francolin, *Francolin froncolinus;* gray francolin, *Ortygornis pondicerianus;* common quail, *Coturnix coturnix;* grey partridge, *Predix predix* and rain quail, *C. coromandelica* (Khalid *et al*., 2020). Partridges are predators of insects, invertebrates and consume seed in trophic level. For example; grey partridge, *P. predix* consumes a wide range of insects (Moreby *et al*., 2006; Homberger *et al*., 2021), including arthropods (Potts, 1986), spiders (Beck and Toft, 2000), and coleopterans (Bilde and Toft, 1994).They are ecosystem engineers and play crucial role seed dispersion, and also indicate health and productivity of particular habitats (Gregory *et al*., 2003; Weir and Corlett, 2007; Viana *et al*., 2016; Corlett, 2017).

Besides controlling insect and pest populations, they are source of food (prey) for other carnivore fauna, i.e., mammals, reptiles and raptors, as well as bushmeat for humans (Taylor *et al*., 2006; Whelan *et al*., 2008; Kellermann *et al*., 2008). Additionally, partridges are important components of food chain of forests and grassland

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ecosystems. The habitat selection among partridges varies from species to species depending occurrence of food richness and diversity, shelter from harsh weather, and safety from predators (Ong-In *et al*., 2016; Hille *et al*., 2021; Scholl *et al*., 2023). For example; grey partridge-*Perdix perdix* prefers mosaic landscape encompassing grasses and shrubby vegetation, which provide sufficient food resources and shelter from predators (Joannon *et al*., 2008; Pandian, 2021; Scholl *et al*., 2023).

Poaching is a long-standing anthropogenic activity, practiced for sport or subsistence purposes (Champagnon *et al*., 2012). Due to pawning activities, habitat degradation, and uncontrolled pesticide use, game bird populations have declined in recent years. In response to decreasing populations of certain game species, farm-reared partridges were released to boost population in the wild. The poaching of the partridges is often done for bushmeat, pet trade and recreation. A number of studies have shown that heavy predation, introduction of invasive species, and pest trade has declined across the heterogeneous habitats (Sokos *et al*., 2008; Díaz–Fernández *et al*., 2012) due to habitat loss (Gaudioso *et al*., 2002; Grimmett *et al*. 2008), trapping for pet (Alves and Rosa, 2010; Mahmood *et al*., 2011) and illegal hunting (Katwal *et al*., 2023). Even though, partridges play a crucial role in maintaining the ecosystem functions (Champagnon *et al*., 2012). Blanco–Aguiar (2007) and Chattopadhyay al. (2021) stated that population of red–legged partridges has declined 95.0%. The major factors that contribute the partridges population includes scarcity of food, over hunting, a high rate of predation, overgrazing, prolonged drought, extreme cold, and the uncontrolled use of pesticides (Khalid *et al*., 2017; Basit *et al*., 2021). Moreover, due to the hunters cruel actions, partridges injured and leave babies to starve to death (Mahmood *et al*., 2011).

In sufficient information is available on the effects of populations of partridges due to poaching and no detailed study has been carried out to quantify the impact of hunting on partridge in the study area. Even though, partridges provide wide range of ecological, biological, environmental, and productive services to humans as well as for other species. Hence, this study was conducted to quantifying the effects of poaching on four partridge species on their population and distribution to understand the effects of poaching and to prepare an appropriate conservation management plan to reduce the threats and enhance the population in the study area.

MATERIALS AND METHODS

Study area

The study area is located between 31° 50’ 53.34” N and 70° 54’ 41.75” E (Fig. 1) and covers 9,334 km^2, a densely populated area, with 1.627 million people (Census Report, 2017). Female to male ratio is 940 females for every 1000 males. The literacy rate ranges from 56.55% for male and 29.39% for female.

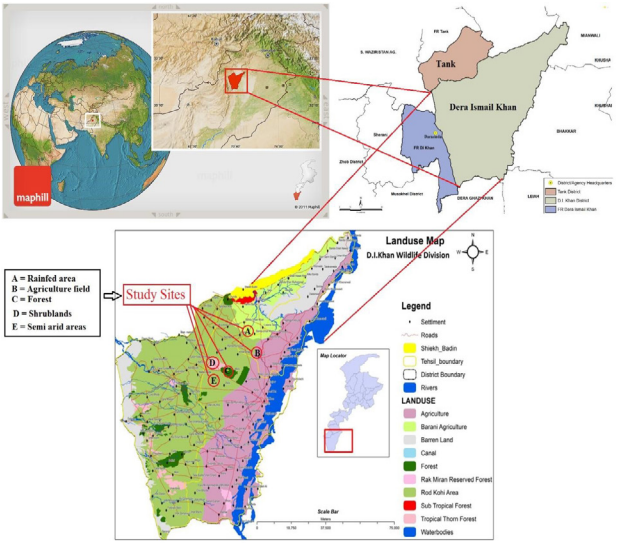

Fig. 1. Location map of the study area.

Vegetation cover is comprised of *Acacia nilotica, A. modesta, A. catechu, Cordia myxa*, *Dilbergia sissoo*, *Tamarix aphylla, T. dioica, Periploca aphylla, Amaranthus viridis*, *Aristida adscesenoions*, *Asphodelus tenuifolius*, *Astragalus hamosus*, *Boerhavia procumbens*, *Bromus japonicus*, *Calotropis procera*, and *Capparis decidua*.

The weather of the study area is mostly dry and varied throughout the year, e.g., the hottest months are May, June, and July (38-40 ºC) and the coldest months are December, January, and December (6-8 ºC) (Fig. 2). Throughout the year, rainfall pattern varied, i.e., highest precipitation recorded in March (423.3mm) and the low rainfall detected in December (17.7mm).

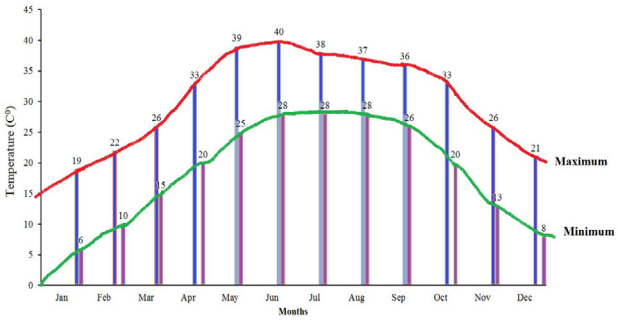

Fig. 2. Month wise temperature of the study area.

Data collection

Distance sampling point count method is a newly advance and standard sampling technique that has been widely used for avian surveys across the habitats. It provides quantitative information on avian species dispersion exploiting heterogeneous habitats (Farnsworth *et al*., 2005; Volpato *et al*., 2009; Chiatante *et al*., 2013). The abundances and distributions of four partridge's in five potential sites namely; agricultural field, grassland, orchard, forest and low lying hilly terrain of Dera Ismail Khan were recorded employing the Distance sampling point count method. In total, 200 point count stations (40 point count stations in each site). These sites were selected randomly in heterogeneous landscapes in order to obtain the higher number of individuals of partridges. The surveys were performed between 0800 to 1200 h in the field.

However, during rainy and cloudy days the surveys were didn't performed because most of the partridges hided in the vegetation. The methodology followed was followed as described by Thomas *et al*. (2010), Fonturbel *et al*. (2020) and Morrison and Peitz (2020).

Questionnaire survey

In addition to the field surveys, a questionnaire surveys were also performed to determine the effects of poaching on partridges in the study area. During questionnaire survey, face to face interviews of 213 respondents were recorded using pre-tested questionnaire proforma. Data from the questionnaires was gathered and entered into the MS Excel spreadsheet for further analysis.

Data analysis

The partridge's relative abundance (SA) was determined using equation; SA= n/Nx100 (Anderson, 2017). where, n denotes the number of a particular number of individuals of partridge species and N denoted the total number of all recorded numbers of four partridge's species.

The partridge species diversity, species richness and distribution (Evenness) was determined employing the Community Analysis Package Software (Version 4.5) by Henderson and Seaby (2007).

The overall and species wise diversity of partridge was determined using Shannon-Weiner index (H′) formula (Shannon, 1949).

H' = ∑[(pi) × ln(pi)]

Where, H' is the diversity, S is the number of species, i is the abundance of species, N is the number of individuals, and pi is the relative abundance of each species and ln = the natural logarithm.

Partridge's species richness of each and overall was ascertained using the Margalef's species richness index (Margalef's, 1958).

$$R = \frac{(S-1)}{N}$$

Where, S is total number of species and N is total number of individuals detected in the research area.

Partridge's species evenness was determined using the McIntosh's evenness index formula (McIntosh, 1967).

$$D_{MC} = \frac{N - \sqrt{\sum_{i-1}^{s} n_i^2}}{N - \sqrt{N}}$$

Where, S denoted for the number of partridges in the study area, *ni* denoted for the relative abundance 149 of detected partridges number of individuals, and N is the total relative abundance of each partridge 150 species in the study area.

The relative abundance of partridges was compared using 153 Kruskal-Wallis Nonparametric H test and Tukey's Honestly Significant Difference (HSD) test using Statistix Analytical Software; Version 8.1 (McGraw-Hill, 2008) to determine the significant difference 155 among partridge relative abundance in the study area.

$$H = \frac{12}{n(n+1)} \sum \frac{R_i^2}{ni} - 3(n+1)$$

Where, *n* is the total number of observations, *R* is the sum of the ranks of each sample, and *ni* is 159 number of each habitat.

Community analysis package software was used to compare the partridge frequency distribution with the rarefaction curve (Version 4.5) by Henderson and Seaby (2007).

RESULTS

Frequency of partridges in the study area

In total, 4084 individuals of four species black partridge (*Francolinus francolinus*; 842 individuals), grey partridge (*Perdix perdix*; 1528 individuals), see-see partridge (*Ammoperdix griseogularis*; 510 individuals) and chukar partridge (*Alectoris chukar*; 1204 individuals) were documented in the study area. The detection of partridge individuals was varied from month to month in the study area, i.e., the 173 highest number of individuals were recorded during June 2023 (281 individuals; 6.881%) and low 174 number of individuals was detected during December 2023 (104 individuals; 2.547%). Furthermore, 175 during the study period, four partridge species were observed to vary significantly in frequency, i.e., $F_{4, 87}$ 176 = 41.900, $p < 0.05$ (Table I).

Partridges abundance and sex ratio

Grey partridge, *Perdix perdix* was the most prevalent species (37.414 %) and see–see partridge, *Ammoperdix griseogularis* was the least abundant (12.488 %). The population structure of the partridges was dominated by

Table I. Species wise partridge's detection from March 2023 to December 2023 in the study area.

Month name 2022 to 2023	Black partridge	Grey partridge	See-see partridge	Chukar partridge	Total (%)
2022					
March	41	71	15	72	199 (4.873)
April	26	36	10	64	136 (3.330)
May	72	41	20	50	183 (4.480)
June	58	88	25	72	243 (5.950)
July	37	70	18	39	164 (4.016)
August	34	62	54	64	214 (5.241)
September	22	34	16	55	127 (3.110)
October	18	59	14	34	125 (3.061)
November	22	76	24	39	161 (3.942)
December	55	88	32	44	219 (5.362)
2023					
January	28	52	15	36	131 (3.208)
February	32	58	24	39	153 (3.746)
March	43	79	28	40	190 (4.652)
April	52	77	32	60	221 (5.411)
May	47	93	38	78	256 (6.268)
June	52	104	36	89	281 (6.881)
July	44	92	29	71	236 (5.779)
August	36	74	22	50	182 (4.456)
September	42	88	18	68	216 (5.289)
October	33	77	16	58	184 (4.505)
November	28	65	14	52	159 (3.893)
December	20	44	10	30	104 (2.547)
Total	842	1528	510	1204	4084

males, i.e., black francolins (M = 41.567%), grey partridges (M = 42.343%), see–see partridges (M = 42.549%) and chukar partridges (M = 43.355%) than females, i.e., black francolins (F = 30.285%), grey partridges (F = 32.657%), see–see partridges (F = 35.294%) and chukar partridges (F = 34.718%). However, chicks sex ratio was didn't identify due to color and size similarities (Table II).

Diversity indices of partridges in the study area

The partridge species diversity, species richness, and distribution vary in the study area. Gray partridges exhibited the highest species diversity index (Simpson's Index; D = 20.72 and Shannon's Index; H' = 2.991), and see-see partridges showed the lowest species diversity index (Simpson's Index; D = 18.97 and Shannon's Index; H' = 2.999). Om contrast, the highest species richness (Margalef's Index; R_1 = 3.368 and Menhinick Index; R_2 = 0.974) was detected in the see-see partridges and the lowest species richness (Margalef's Index; R_1 = 2.864 and Menhinick Index; R_2 = 0.563) in grey partridges in the study area. Moreover, the highest species evenness was determined for grey partridge (E_1 = 0.990) and lowest one for see-see partridge (E_2 = 0.987) in the study area (Table III).

Table II. Partridge abundances and sex ratio detected in study area.

Total detected			Total	Sex ratio (%)		
Male	Female	Chicks		Male	Female	Chicks
350	255	237	842 (20.61%)	41.56	30.28	28.14
647	499	382	1528 (37.41%)	42.34	32.65	25.00
217	180	113	510 (12.48%)	42.54	35.29	22.15
522	418	264	1204 (29.48)	43.35	34.71	21.92
			4084 (100%)			

Table III. Overall and species wise diversity indices of partridge in the study area.

Indices	Black partridge	Grey partridge	See-see partridge	Chukar partridge	Overall ± SEM
Diversity indices					
Shannon's index; H'=	3.02	3.05	2.99	3.04	3.06 ± 0.00
Simpson's index; D=	19.98	20.72	18.97	20.64	20.84 ± 0.17
Richness indices					
Margalef's index; R_1=	3.11	2.86	3.36	2.96	2.526 ± 0.07
Menhinick index; R_2=	0.75	0.56	0.97	0.63	0.344 ± 0.04
Evenness indices					
McIntosh's index; E =	0.98	0.99	0.97	0.98	0.992 ± 0.00
Brillion's J index; E_2=	0.98	0.98	0.97	0.98	0.990 ± 0.00

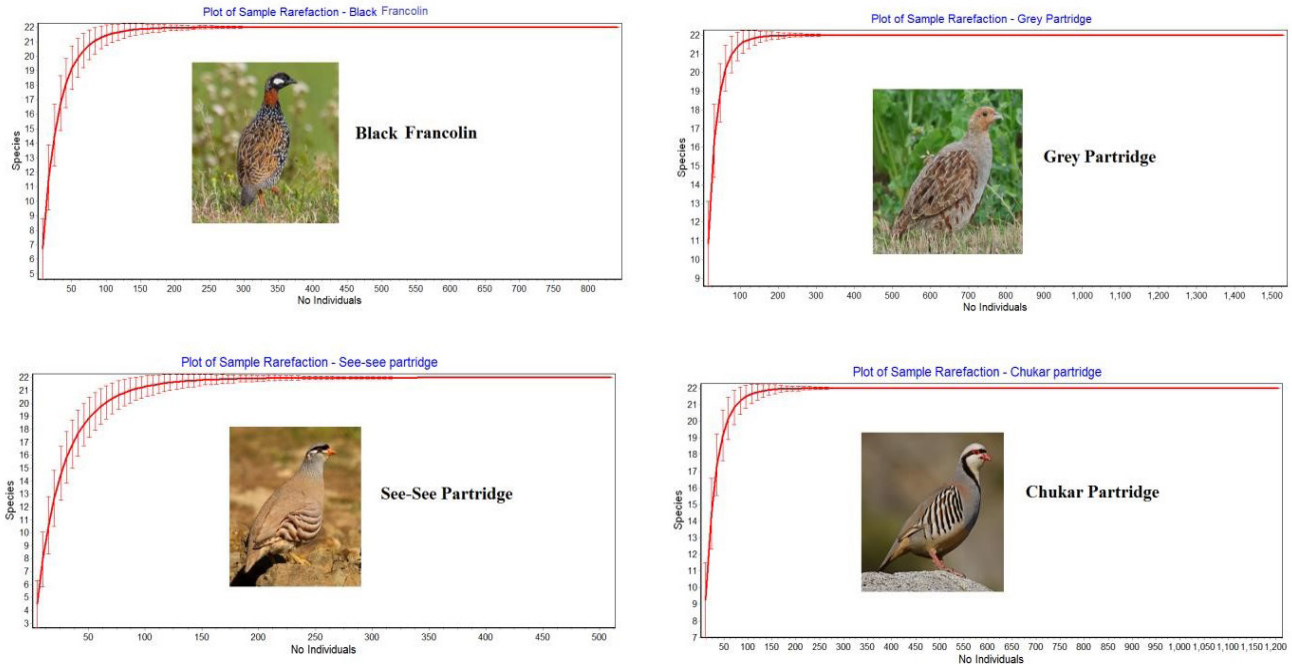

Fig. 3. Sample plot rarefaction curve of each species of partridge in the study area.

Sample plot rarefaction curve

To understand the diversity and dispersion of partridge species in the study area, a sample plot rarefaction curve of each species was quantified using Community Analysis Package (Version 4.0). The rarefaction curve demonstrated the dispersion pattern partridge species in the study area. The flattening of the curve indicates that the number of individuals has been optimized, while the steepness indicates that the individuals of each species distribution and sequence within the study area. The depth and frequency of sequencing of individuals contributes to the understanding of species diversity of partridges within study area. However, the refraction curves of partridges vary from species to species (Fig. 3).

Comparison of partridge individuals in the study area

The hierarchical relationship among four partridge species were examined using the dendrogram hierarchical clustering through Community Analysis Package (Version: 4.0). The dendrogram hierarchical clustering classified the two clusters of partridges, i.e., chukar partridge and gray partridge (cluster one) and see-see partridge and black francolin (cluster two). The cluster one depicting that the chukar partridge and grey partridges are closely related. On the other hand, the cluster two illustrated that black francolins and see-see partridges are closely associated in the in the study area (Fig. 4).

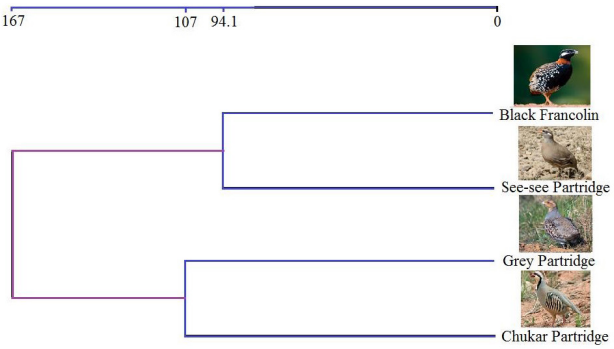

Fig. 4. Dendrogram hierarchical clustering chart indicating the partridges in study area.

Threats to partridges

The respondent stated that partridges are facing severe threat from hunting (27.22 %), poaching (20.65%), habitat loss (15.02%) and habitat disturbance (12.67%). In addition, food scarcity (9.86%), habitat fragmentation (8.92%) and pollution (5.63 %) also contribute the threats to the predators in the study area (Table IV).

Predators of partridges

Partridges are threatened by a variety of natural as well as human-induced predators, just like other animals. Natural predators include jackals, raptors, snakes, wild cats, and mongooses. Human induced predators are tamed

raptors, feral dogs and domestic cats. In the wild as well as in captivity, these predators attacked adult and chick partridges. According to the respondents, there are higher incidents of raptors (35.68%) preying on partridges in the wild, whereas snakes (9.39%) are less common.

Meanwhile, partridges are severely attacked by human tamed pets such as feral dogs (40.82%) and domestic cats (31.92%). However, partridges are also attacked by other pets induced by humans (Table V).

Table IV. Threats to partridge species in the study area.

Threats to partridges	Total number (N)	Percentage
Hunting	58	27.23
Poaching	44	20.65
Habitat loss	32	15.02
Habitat disturbance	27	12.67
Food scarcity	21	9.86
Habitat fragmentation	19	8.92
Pollution	12	5.63
Total	213	100 %

Table V. Partridges predators detected in the study area.

Predators	Respondents number	Percentage
Natural predators		
Raptors	76	35.68
Mongoose	47	22.06
Wild cats	42	19.71
Jackal	28	13.14
Snakes	20	9.39
Human induced predator		
Feral dogs	104	48.82
Domestic cats	68	31.92
Others	41	19.24
Total	213	100 %

Food of partridges

Partridges consume grains, seeds of grasses, as well as insects, worms, and other invertebrates. The diet of partridges varies by species, from adults to chicks, both in the wild and in captivity. In response to respondents' perceptions, adult partridges in captivity are fed seeds and grains (45–55%), followed by insects and invertebrates (15–25%), grasses, twigs, and fruits (5–10%). In comparison, chicks provide insect and invertebrate foods (40-50%), seeds and grains (25-35%), grass twigs and leaves (15-25%), and fruits (10-15%) (Table VI).

Table VI. Food resources given and consumed by partridges in captivity and wilderness.

Food type	Ratio
Adult partridges	
Seeds and grains	45–55%
Insects and invertebrates	15–25%
Twigs and leaves of grasses	10–15%
Berries and fruits	5–10%
Chicks partridges	
Insects and invertebrates	40–50%
Seeds and grains	25–35%
Twigs and leaves of grasses	15–25%
Berries and fruits	10–15%

Poaching of partridges

Different techniques are used to poach or hunt partridges, including trapping with nets, catching with snares, capturing or killing by tamed raptors, hunting with firearms, and egging (illegal egg collection) for various purposes. Partridges are heavily trapped by nets (27.230%) and snares (23.00%), as well as captured by tamed raptors (15.96%). On the other hand, partridges were less at risk from egging in the study area (8.45%) (Table VII).

Table VII. Poaching methods used in the study area for partridges.

Poaching method	Respondents number	Percentage
Trapping by netting	58	27.23
Trapping by snaring	49	23.00
Capturing tamed raptors	34	15.96
Killing by firearms	29	13.61
Killing by tamed raptors	25	11.73
Others (egging)	18	8.45
Total	213	100 %

Breeding of partridges in captivity

Quantifying the breeding ecology and developmental growth of partridges in wild and captivity is crucial. Breeding high quality breeds to ensure long-term effectiveness and a greater number of individuals. It is essential to choose healthy brooders to ensure partridges can easily breed in captivity. Captive breeding programs require appropriate management actions and care. The

breeding of partridges differed between wild and captivity. Throughout the study area, partridge eggs fecundity and clutch size, incubation period, hatching success, and chick fledging vary among species (Table VIII).

Table VIII. Captive breeding of four different types of partridges in the study area.

Captive breeding		Duration and months
Mating months		March, April, May
Nesting months		February – April
Chick rearing by parents		April, May, June
Number of eggs	Gray partridge	9–19
	Chukar partridge	7–13
	Black partridges	5–11
	Red–legged partridge	7–18
Days for incubation		22–27
Numbers of chicks	Gray partridge	6–12
	Chukar partridge	5–9
	Black partridges	4–8
	Red–legged partridge	5–11
Egg hatching success (%)		55–75 (%)
Chick fledging (in days)	Gray partridge	12–15
	Chukar partridge	11–15
	Black partridges	11–14
	Red–legged partridge	11–15

Views of the respondents regarding the captivity of partridges

Like other pet animals, the partridges are extensively kept as pet for various purposes. The purposes of keeping partridge as pet vary from individual to individual, i.e., some people keep partridge as a pet for hobby, trade, spiritual aspiration, aesthetic beauty, calls, meat, and research. Keeping partridges in captivity is crucially influenced by people's attitudes, behaviors, and societal demands. The perceptions of the respondents revealed that mostly people keep the partridges in captivity to generate income (27.23%), followed by entertainment (22.06%). spiritual inspiration (16.90%), and as hobby (14.55%) while only 8.92% stated other purposes (Table IX).

Effects of diseases and stress on partridges in wild and captivity

Partridges are susceptible to various diseases and stresses like the rest of birds. The findings showed that wild partridges are heavily infected by influenza (35.21%), predator-induced stress (24.41%), and Newcastle diseases (22.06%). Habitat-related diseases, however, were less prevalent in partridges (18.31%) in wild. There was a significant increase in respiratory diseases (36.62%) and parasitic diseases (26.29%) among partridges in captivity in comparison with wild partridges (Table X).

Table IX. Purposes of captivity of partridges in the study area.

Purpose of captivity	Respondents number (N)	Percentage
As a business	58	27.23
As entertainment	47	22.06
Spiritual inspiration	36	16.90
As hobby	31	14.55
As a pet	22	10.32
Other purposes	19	8.92
Total	213	100 %

Table X. List of the disease and stress of partridges in wild and captivity of the study area.

Name of disease	Respondents number (N)	Percentage
Diseases in wilderness		
Avian encephalomyelitis (Avian influenza or bird flu)	75	35.21
Newcastle disease	47	22.06
Predator–induced stress	52	24.41
Habitat–related diseases	39	18.31
Total	213	100 %
Diseases in captivity		
Respiratory infections	78	36.62
Coccidiosis (*Eimeria* sp.), Ascarid worm, *Capillaria contorta* (Parasitic Infections)	56	26.29
Stress–related issues	44	20.65
Aspergillosis	35	15.43
Total	213	100 %

Partridges as a source of income for captive breeders

In study area captive breeding of partridges has been done at mass scale to generate the income. Captive breeder generates Rs. 18 to 22 million per year and from wild Rs. 11 to 15 million per annum has also been generated, captivity generates an average income of Rs. 18 to 22 million per year. However, the prices of partridge per individual varied from species to species. It was founded that black partridge was the most expensive bird than other type of partridges. Moreover, prices were found to vary between male, female, and chick partridges (Table XI).

Table XI. Income generated from pet partridges and price values of partridge/individual.

Income generated	Average income in Rs.	
Wild partridges	Rs. 11 to 15 million per annum	
Captive partridges	Rs. 18 to 22 million per annum	
Type of partridge	**Category**	**Price per individual**
Black partridge	Male	Rs. 52000
	Female	Rs. 44000
	Chick	Rs. 6000
Grey partridge	Male	Rs. 42000
	Female	Rs. 29000
	Chick	Rs. 4000
See–see partridge	Male	Rs. 48000
	Female	Rs. 36000
	Chick	Rs. 4500
Chukar partridges	Male	Rs. 51000
	Female	Rs. 38000
	Chick	Rs. 5500

Demographic information of respondents

Demographic survey was carried out through pre-tested questionnaire surveys from 213 respondents, out of which 80.28% were males and 19.71% were female. The age distribution of respondents was varied from 15 to > 60 years (Table XII). The marital status, ethnicity (cast), origin, education level, profession and income of respondent varied in the study area (Table XII).

Table XII. Demographic information of 213 respondents in the study area.

Variables	Total numbers (N)	Percentage
Age group		
30–45	84	39.43
45–60	58	27.23
15–30	44	20.65
> 60	27	12.67
Total	213	
Sex of respondents		
Male	171	80.28
Female	42	19.71
Total	213	
Marital status		
Married	102	47.88
Widows	42	19.71
Divorced	36	16.90
Single	33	15.49
Total	213	
Cast of respondents		
Pathan	121	56.80
Saraiki	68	31.92
Others	24	11.26
Total	213	100 %
Origin of the respondents		
Daraban Tehsil	63	29.57
Kulachi Tehsil	52	24.41
Paharpur Tehsil	48	22.52
Paroa Tehsil	35	16.43
Dera Ismail Khan Tehsil	15	7.04
Total	213	
Education level of the respondents		
Un–educated	35	16.43
Primary	37	17.37
Secondary	39	18.31
Higher Secondary	28	13.14
Bachelor (BS)	32	15.02
MS/M.Phil.	23	10.79
PhD	19	8.92
Total	213	
Monthly income of respondent		
<10,000	21	9.86
10,000–20,000	55	25.82
21,000–30,000	61	28.63
31,000–40,000	42	19.71
40,000–50,000	34	15.96
Total	213	
Profession of the respondents		
Government servant	31	14.55
Landlord	27	12.67
Hunter	26	12.20
Businessman	24	11.26
Farmer	23	10.79
Sailor	23	10.79
Dealer	16	7.51
Driver	15	7.04
Carpenter	10	4.69
Security guards	8	3.75
Mason	6	2.81
Labor	4	1.87
Total	213	

DISCUSSION

The first step in devising an effective conservation strategy is to understand the habitat status, current population status, potential threat and dispersion of partridge species. Partridges are galliform game birds with a wide range of distribution across Asia, Europe and Africa. Partridges are among the most threatened bird species due to their large size and slow movement (Keane *et al*., 2005; Brickle *et al*., 2008). A number of human activities are putting intense pressure on these species, including illegal hunting, poaching, habitat disturbance, land conversion, and human settlements (Dai *et al*., 1998; BirdLife International, 2008).

Black francolin (*Francolinus francolinus*), grey francolin (*Francolinus pondicerianu*), chukar partridge (*Alectoris chukar*), see-see partridge (*Ammoperdix griseogularis*), common-buttonquail (*Turnix sylvaticus*), common quail (*Coturnix coturnix*), and rain quail (*C. coromandelica*) are widely distributed partridges in the study area (Kylanpaa, 2000; Lepage, 2024). The black francolin, grey francolin and chukar partridge are widely distributed were frequently documented in agriculture fields, grasslands (pastures), semi-desert areas, shrub lands, and hilly terrain sides (Ahmad *et al*., 2015; Khailil and Anwar, 2016; Basit *et al*., 2021; Scholl *et al*., 2023). These occurrences of these partridges could be due to habitat suitability that provides ample food resources and shelter from harsh weather and predators. The other reason could be that, these areas are prevalent for foraging and breeding.

In addition, sufficient population of these partridges were recorded in the captivity that indicated the local communities keep the partridge as pet for breeding purposes in order to generate income. They sell the adult as well as chick to the people and also in market at suitable prices. The price of adult and chick varies from species to species. Moreover, it is identified that in captivity partridges also facing various threats, i.e., predation by domestic and wild predators. The poaching, i.e., illegal hunting and trapping for pet trade, uncontrolled pesticide use in agriculture crops, and habitat loss due to land transformations are major contributing factor due to which the populations of partridges has declined at alarm rate (Aiyadurai *et al*., 2010; Benitez-Lopez *et al*., 2017; Katuwal *et al*., 2023). Currently, poaching for illegal trade is done extensively declined partridge populations in the wild habitats. The poaching has been done to meet the demand of the market (Kamp *et al*., 2015; Greengrass, 2016), pet trade, recreation (Chang *et al*., 2017; Commercon *et al*., 2021), as well as financial returns (Heim *et al*., 2021). It has been illustrated that, poachers trap and hunt the partridges for consumption as meat (Van Vliet *et al*., 2017) or for traditional medicinal uses (Jekins *et al*., 2017), as a result, the population of partridges is decreasing day by day. Such type of finding previously has been reported by Khalid *et al*. (2017).

The partridges were detected in a variety of habitats, including grasslands, agricultural fields, scrubland, riversides, rangelands, and subtropical lowland forests. These area were comprised on of gum Arabic tree *Acacia nilotica,* shisham *Dalbergia sissoo*, cutch tree *Acacia catechu, A. jacquemontii*, Chinese jujube, *Ziziphus mauritiane*, China berry tree, *Melia azedarach,* tall shrubs *Prosopis cinerira*, *P. juliflora*, bada Peelu *Salvadora oleoides*, river red gum tree *Eucalytpus camaldulensis,* athel pine *Tamarix aphylla*, white mulberry *Morus alba*, common fig *Ficus carica*, and mesquite *Procepis joliflora* tree species; shrub species, i.e., red tamarisk *Tamarix dioica*, wild jujube *Zizyphus nummalaria,* apple of Sodom *Calotrpis procera,* karira *Capparis decidua,* downy thorny apple, *Datura alba,* hammada elegans *Haloxylon salicornicum,* Khar or Sajjil *H. recurvum* and broadleaf cattail bulrush *Typha latifolia,* phog, *Calligonum polygonoides,* creeping launea *Launaea procumbens* and grass species, i.e., baconweed *Chenopodium album,* foxtail buffalo grass *Cenchrus ciliaris,* Bermuda grass *Cynodon dactylon,* black speargrass *Heteropogon contortus,* annual meadow grass *Poa annua,* variable flatsedge *Cyperus difformis,* Cogongrass *Imperata cylindrical*, little lovegrass *Eragrostis minor*, saltwort, *Caroxylon imbricatum,* Kapok bush *Aerva javanica,* khimp *Leptadenia pyrotechnica,* needlegrass *Aristida hystricula,* sewangrass *Lasiurus hirsutus,* Jawrankhush grass, *Cymbopogon jwarancusa,* bitter cucumber *Citrullus colocynthis,* camelthorn, *Alhagi maurorum*, red Jasmine, *Heliotropium strigosum,* prostrate spurge, *Euphorbia prostrate,* blood–red reedgrass, *Panicum atrosanguineum*, Oriental fountain grass, *Pennisetum orientale* and Kans grass, *Sacchrum spontaneum.* The trees, shrubs and grasses have great importance for partridge species as they provide shelter, roosting, nesting and foraging grounds. It was founded that the floristic structure and composition significantly affect partridge distribution in the study area. This could be that, partridges directly associated with vegetation structure and composition. A partridge's habitat selection depends on the availability of food, dispersal of the chicks, shelter, and suitability of the breeding grounds and chick raising areas. Similar findings have been reported by Behbash *et al*. (2010) in Iran, Fisher *et al*. (2012) in Russia, and Kumar *et al*. (2020) in the north-west Himalayas of India.

The local inhabitants and hunters were expert in poaching of partridges in the study area and provided the vital information on various ecological aspects of partridges. According to them, they used various tactics

to trap or hunt the partridges in the study area. They also stated that partridges are facing various threats by natural predators, i.e., kestrels, falcons, shikras, hawaks, snakes, wild cats, mongoose, feral cats and dogs. Previously it also has been reported that partridges are preyed by wild cats, jackals, mongooses, falcons, harriers, and snakes (Alves and Rosa, 2010; Mahmood *et al*., 2011; Arroyo *et al*., 2012; Hussain and Khan, 2023). However, the severity and effects of predators varies from site to site depending on occupancy of predators. In addition, partridges are also susceptible to various diseases such as avian encephalomyelitis (influenza a virual disease), aspergillosis (fungal disease) caused the respiratory illnesses, and coccidiosis (*Eimeria* sp.), ascarid worm, *Capillaria contorta* (nematodes parasites). Infestation weakens the birds and makes them vulnerable to diseases, which lowers reproduction success and mortality. The findings are consistent with previous research red-legged partridges have gastrointestinal parasitic infections caused by nematodes, tapeworms, and trematodes (Arcenillas-Hernandez *et al*., 2022), and grey partridges are infected with bacterial disease caused by *Mycoplasma gallisepticum* (Vitula *et al*., 2011). Khatattak *et al*. (2012) also report gray partridges (*Francolinus pondicerianus*) and black partridges (*Francolinus francolinus*) are also attacked by ectoparasites, such as lice, mites, ticks, and fleas. Such parasites attack the skin under feathers and suck the bird's blood.

CONCLUSION

Based on finding, it has concluded that partridges are facing ample threats from humans and nature alike strict bans on poaching, pesticide use, and pet entry into core habitats. In addition, the perceptions of respondents and visual field observations clearly indicate that anthropogenic activities negatively effect on partridge distribution and population. Partridges become more appealing for conservation and appropriate management that they live in the wild with smoothness and harmony in order to enhance the population and contribute their crucial role in ecosystem functions. More detailed studies are required on a larger scale covering the ecological behaviors of partridges and examining their population trends and endangerment in future.

DECLARATIONS

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Ethical statement and IRB approval

The stressing or exposing practices that may cause restraints and endangerment during data collection were avoided in order to preserve the existence of partridges in Dera Ismail Khan as well as their habitats. The ethical community of Shaheed Benazir Bhutto University Sheringal, Dir Upper granted permission to ensure the safety of partridges in the study area. To avoid potential risks and threats to fauna species, we followed the research protocols and informed the Wildlife Department well.

Generative AI or AI-assisted technology statement

The authors declare that no Generative AI was used in the creation of this manuscript.

Statement of conflict of interest

The authors have declared no conflict of interest.

REFERENCES

Aebischer, E.J.M. and Lucio, M.J., 1997. The red–legged partridge. In: *The EBBC atlas of European breeding birds: Their distribution and abundance* (eds. E.J.M. Hagemeijer and M.J. Blair). Poyser, London. pp. 903. 208–209, ISBN: 978–0–85661–091–2.

Ahmad, B., Anwar, M. and Khan, M.S., 2015. Habitat study of chukar partridge (*Alectorus chukar*) in district Malakand. A case study of town Thana. *Pak. J. For*., **65**: 54–65.

Aiyadurai, A., Singh, N.J. and Milner–Gulland, E.J., 2010. Wildlife hunting by indigenous tribes: A case study from Arunachal Pradesh, North–East India. *Oryx*, **44**: 564–572. https://doi.org/10.1017/S0030605309990937

Ali, S. and Ripley, S.D., 2002. *Handbook of the birds of India and Pakistan*. Oxford University Press, Delhi India. Edition 2nd, pp. 3121. ISBN: 9780195655063.

Alves, R.R.N. and Rosa, I.L., 2010. Trade of animals used in Brazilian traditional medicine: trends and implications for conservation. *Hum. Ecol*., **85**: 691–704. https://doi.org/10.1007/s10745-010-9352-0

Anderson, V., 2017. Criteria for evaluating quantitative research. *Hum. Resour. Dev. Quart*., **28**: 125–133. https://doi.org/10.1002/hrdq.21282

Arcenillas–Hernandez, I., Martinez–Carrasco, C., Tizzani, P., Berriatua, E. and Del Rocio Ruiz de Ybanez, M., 2022. Gastrointestinal parasites in

red–legged partridges (*Alectoris rufa*) hunted in Spain: a warning to game managers. *Vet. Res. Commun*., **46**: 1051–1062. https://doi.org/10.1007/s11259-022-09968-7

Arroyo, B., Delibes–Mateos, M., Diaz–Fernandez, S. and Vinuela, J., 2012. Hunting management in relation to profitability aims: Red–legged partridge hunting in central Spain. *Eur. J. Wildl. Res*., **58**: 847–855. https://doi.org/10.1007/s10344-012-0632-4

Basit, A., Anwar, M., Rakha, B.A., Ansari, M.S., Manawar, N. and Akhter, A., 2021. Population density of black francolin (*Francolinus francolinus*) in Kala Chitta range, Pakistan. *J. Anim. Pl. Sci*., **31**: 1537–1541. https://doi.org/10.36899/JAPS.2021.5.0356

Basit, A., Anwar, M., Rakha, B.A., Ansari, M.S., Manawar, N. and Akhter, A., 2021. Population density of black francolin (*Francolinus francolinus*) in Kala Chitta range, Pakistan. *J. Anim. Pl. Sci*., **21**: 822–829. https://doi.org/10.36899/JAPS.2021.5.0356

Beck, J. and Toft, S., 2000. Artificial selection for aphid tolerance in the polyphagous predator *Lepthyphantes tenuis* (Araneae: Linyphiidae). *J. Appl. Ecol*., **37**: 547–556. https://doi.org/10.1046/j.1365-2664.2000.00514.x

Behbash, R., Karami, M., Mahiny, A., Nabavi, M. and Khorsasani, N., 2010. Effect of plant cover on presence of black francolin (*Francolinus francolinus*) in Khouzestan Province, Southwestern Iran. *Afr. J. Biotechnol*., **9**: 3847–3851.

Benitez–Lopez, A., Alkemade, R., Schpper, A.M., Ingram, D.J., Verweiji, P.A., Eikelboom, J.A.J., Huijbregts, M.A.J., 2017. The impact of hunting on tropical mammal and bird populations. *Science*, **356**: 180–183. https://doi.org/10.1126/science.aaj1891

Bilde, T. and Toft, S., 1994. Prey preference and egg production of the carabid beetle *Agonum dorsale*. *Entomol. Exp. Appl*., **73**: 151–156. https://doi.org/10.1111/j.1570-7458.1994.tb01850.x

BirdLife International, 2008. *Threatened birds of the world*. BirdLife International, Cambridge, UK.

Blanco–Aguiar, J.A., 2007. *Variacion espacial en la biologia de la perdiz roja (Alectoris rufa): Una aproximacion multidisciplinar*. Ph.D. thesis, Universidad Complutense de Madrid, Spain.

Blanco–Aguiar, J.A., Virgós, E. and Villafuerte, R., 2004. Perdiz Roja (*Alectoris rufa*). In: *Libro rojo de las aves de España* (eds. A. Madroño, C. González and J.C. Atienza). Dirección General para la Biodiversidad–SEO/BirdLife, Madrid, pp. 182–185.

Brickle, N.W., Duckworth, J.W., Tordoff, A.W., Poole, C.M., Timmins, R. and Philip, J.K., 2008. The status and conservation of Galliformes in Cambodia, Laos and Vietnam. *Biodiv. Conserv*., **17**: 1393–1427. https://doi.org/10.1007/s10531-008-9346-z

Buenestado, F.J., Ferreras, P., Delibes–Matoes, M., Tortosa, F.S., Blanco–Aguir, J.A. and Villafuerte, R., 2008. Habitat selection and home range size of red–legged partridges in Spain. Agric. Ecosyst. Environ., 126(3-4): 158–162. https://doi.org/10.1016/j.agee.2008.01.020

Cetin, O., Kirikci, K. and Gulsen, N., 1997. Some productivity characteristics of chukar partridges (*Alectori chukar*) in different management conditions. *Eurasian J. Vet. Sci*., **13**: 5–10.

Champagnon, J., Elmberg, J., Guillemain, M., Gauthier–Clerc, M. and Lebreton, J.D., 2012. Conspecifics can be aliens too: A review of effects of restocking practices in vertebrates. *J. Nat. Conserv*., **20**: 231–241. https://doi.org/10.1016/j.jnc.2012.02.002

Chang, C.H., Barnes, M.L., Frye, M., Zhang, M., Quan, R.C., Reisman, L.M.G., Levin, S.A. and Wilcove, D.S.W., 2017. The pleasure of pursuit: Recreational hunters in rural Southwest China exhibit low exit rates in response to declining catch. *Ecol. Soc*., **22**: 43. https://doi.org/10.5751/ES-09072-220143

Chattopadhyay, B., Forcina, G., Garg, K.M., Irestedt, M., Guerrini, M., Barbanera, F. and Rheindt, F.E., 2021. Novel genome reveals susceptibility of popular gamebird, the red-legged partridge (*Alectoris rufa*, Phasianidae), to climate change. Genomics, **113**: 3430–3438. https://doi.org/10.1016/j.ygeeno.2021.08.010

Chiatante, G., Meriggi, A., Giustini, D. and Baldaccini, N.E., 2013. Density and habitat requirements of red-legged partridge on Elba Island (Tuscan Archipelago, Italy). *Ital. J. Zool*., **80**: 402–411. https://doi.org/10.1080/11250003.2013.806601

Comercon, F.A., Zhang, M. and Solomon, J.N., 2021. Social norms shape wild bird hunting: A case study from southwest China. *Glob. Ecol. Conserv*., **32**: e01882. https://doi.org/10.1016/j.gecco.2021.e01882

Corlett, R.T., 2017. Frugivory and seed dispersal by vertebrates in tropical and subtropical Asia: An update. *Glob. Ecol. Conserv*., **11**: 1–22. https://doi.org/10.1016/j.gecco.2017.04.007

Dai, B., Dowell, S.D., Martins, R.P. and William, S.R. 1998. Conservation status of the *Sichuan hillpartridge, Arborophila rufipectus* in China.

Biodiv. Conserv., **8**: 349–359. https://doi.org/10.1017/S0959270900002112

Diaz–Fernandez, S., Arroyo, B., Casas, F., Martinez–Haro, M. and Vinuela, J., 2013. Effects of game management on wild red–legged partridge abundance. *PLoS One*, **8**: e66671. https://doi.org/10.1371/journal.pone.0066671

Diaz–Fernandez, S., Vinuela, J. and Arroyo, B., 2012. Harvest of red–legged partridge in central Spain. *J. Wildl. Manage.*, **76**: 1354–1363. https://doi.org/10.1002/jwmg.391

Farnsworth, G.L., Nichols, J.D., Sauer, J.R., Fancy, S.G., Pollock, K.H., Shriner, S.A. and Simons, T.R., 2005. Statistical approaches to the analysis of point count data: A little extra information can go a long way 1. USDA Forest Service Gen. Technical Report PSW–GTR–191.200. Accessed on November 16, 2024 at URL: https://www.researchgate.net/publication/252145574_Statistical_Approaches_to_the_Analysis_of_Point_Count_Data_A_Little_Extra_Information_Can_Go_a_Long_Way1#fullTextFileContent

Fisher R.A., Valente, J.J., Guilfoyle, M.P. Kaller, M.D., Jackson, S.S. and Ratti, J.T., 2012. Bird community response to vegetation cover and composition in riparian habitats dominated by Russian olive (*Elaeagnus angustifolia*). *Northwest Sci.*, **86**: 39–52. https://doi.org/10.3955/046.086.0104

Fonturbel, F.E., Rodriguez–Gomez, G.B., Fernandez, N., Gracia, B., Orellana, J.I. and Castano–Villa, G.J., 2020. Sampling understorey birds in different habitat types using point counts and camera traps. *Ecol. Indicat.*, **119**: 106863. https://doi.org/10.1016/j.ecolind.2020.106863

Fuller, R.A., Carroll, J.P. and McGown, P.J.K., 2000. *Partridges, quails, francolins, snowcock, guineafowl, and turkeys. Status, survey and conservation action plan 2000–2004*. WPA/BirdLife/SSC Partridge, Quail, and Francolin Special Group. IUCN, Gland, Switzerland and Cambridge, UK and World Pheasant Association, Reading, UK. Vii + 63pp. ISBN: 2–8317– 0538–X.

Gaudioso, V.R., Alonso, M.E., Robles, R., Garrido, J.A. and Olmedo, J.A., 2002. Effects of housing type and breeding system on the reproductive capacity of the red–legged partridge (*Alectoris rufa*). *Poult. Sci.*, **81**: 169–172. https://doi.org/10.1093/ps/81.2.169

Greengrass, E., 2016. Commercial hunting to supply urban markets threatens mammalian biodiversity in Sapo National Park, Liberia. *Oryx*, **50**: 397-404.

Gregory, R.D., Noble, D., Field, R., Marchant, J., Raven, M. and Gibbons, D.W., 2003. Using birds as indicators of biodiversity. *Ornis Hung.*, **12**: 11–24.

Grimmett, R., Roberts, T. and Inskipp, I., 2008. *Birds of Pakistan*. Christopher Helm, London.

Abbas, H.N.T. and Noori, A.S., 2009. Distribution, population and ecology of black francolin *Francolinus francolinus* bogdanovi on the sistan plain, in relation to plant coverage and drought. *Podoces*, **4**: 28–36.

Heim, W., Chan, S., Holzel, N., Ktitorov, A., Mischenko, A. and Kamp, J., 2021. East Asian bunting: Ongoing illegal trade and encouraging conservation responses. *Conserv. Sci. Pract.*, **3**: e405. https://doi.org/10.1111/csp2.405

Henderson, P. and Seaby, R., 2007. *Community analysis package 4.0*. Pisces Conservation Ltd, Lymington, UK.

Hille, S.M., Scoll, E.M. and Schi–Braun, S., 2021. Rural landscape dynamics over time and its consequences for habitat preference patterns of grey partridge *Perdix perdix*. *PLoS One*, **16**: e0255483. https://doi.org/10.1371/journal.pone.0255483

Homberger, B., Korner–Nievergelt, F., Jenni–Eierman, S., Duplain, J., Lanz, M. and Jenni, L., 2021. Integrating behavior, physiology and survival to explore the outcome of reintroduction: A case study of grey partridge. *Anim. Behav.*, **176**: 145–156. https://doi.org/10.1016/j.anbehav.2021.04.005

Hussain, A. and Khan, A.A., 2023. Wild birds trade in Dera Ismael Khan and Bannu divisions of Khyber Pakhtunkhwa (KPK) Province, Pakistan. *Braz. J. Biol.*, **83**: e247915. https://doi.org/10.1590/1519-6984.247915

Jenkins, H.M., Mammides, C. and Keane, A., 2017. Exploring differences in stakeholders perceptions of illegal bird trapping in Cyprus. *J. Ethnobiol. Ethnomed.*, **13**: 67. https://doi.org/10.1186/s13002-017-0194-3

Joannon, A., Bro, E., Thenail, C. and Baudry, J., 2008. Crop patterns and habitat preferences of the grey partridge farmland bird. *Agron. Sustain. Dev.*, **28**: 379–387. https://doi.org/10.1051/agro:2008011

Johnsgard, P.A., 1988. *The quails, partridges, and francolins of the world*. Oxford University Press, New York, USA.

Kamp, J., Oppel, S., Ananin, A.A., Durnev, Y.A., Gashev, N., Holzel, N., Mischenko, A.L., Pessa, J., Smirenski, S,M., Strelnikov, E.G., Timonen, S., Wolanska, K. and Chan, S., 2015. Global population collapse in a superabundant migratory bird and illegal trapping in China. *Conserv. Biol.*, **29**: 1684–1694. https://doi.org/10.1111/cobi.12537

Katwal, H.B., Sharma, H.P., Thakur, R.K., Rokka, P.,

Mandal, D.N., Baral, H.S. and Quan, R.H., 2023. Illegal trapping and local trade of farmland birds in Madesh Province, Nepal. *Glob. Ecol. Conserv.*, **42**: e02391. https://doi.org/10.1016/j.gecco.2023.e02391

Keane, A., Brooke, M.D.L. and Mcgowan, P.J.K., 2005. Correlates of extinction risk and hunting pressure in game birds (Galliformes). *Biol. Conserv.*, **126**: 216–233. https://doi.org/10.1016/j.biocon.2005.05.011

Kellermann, J.L., Johnson, M.D., Stercho, A.M. and Hackett, S.C., 2008. Ecological and economic services provided by birds on Jamaican Blue Mountain Coffee farm. *Conserv. Biol.*, **22**: 1177–1185. https://doi.org/10.1111/j.1523-1739.2008.00968.x

Khailil, S. and Anwar, M., 2016. Habitat preference of grey francolin (*Francolinus pondicerianus*) in salt range, Punjab. *J. Anim. Pl. Sci.*, **26**: 842–849.

Khalid, M., Hussain, T., Farooq Z., Abbas, K. and Babar, M.E., 2020. Mitochondrial Cyt-b and Cox1 gene based molecular diversity and phylogenetic analysis of chukar partridge (*Alectoris chukar*). *Pakistan J. Zool.*, **52**: 1607–1610. https://doi.org/10.17582/journal.pjz/20181011191004

Khalid, S., Awan, M.S., Minhas, R.A., Ashraf, N., Ahmed, K.B., Shafi, N. and Abassi, S., 2017. Distribution and habitat use of avian fauna of Rawalakot city and its surroundings, Azad Jammu and Kashmir, Pakistan. *Pakistan J. Zool.*, **49**: 2331– 2334. https://doi.org/10.17582/journal.pjz/2017.49.6.sc4

Khattak, R.M., Ali, S., Jahangir, M., Khan, M.N., Rasul, A. and Iqbal, F., 2012. Prevalence of ectoparasites in wild and domesticated grey partridges (*Francolinus pondicerianus*) and black partridges (*Francolinus francolinus*) from Khyber Pakhtoonkhwa Province of Pakistan. *Pakistan J. Zool.*, **44**: 1239–1244.

Kumar, A., Sharma, D.K., Lochan, R., Dewan, S. and Negi, S., 2020. Relative abundance, habitat preference, and breeding ecology of Asian black francolin, *Francolinus francolinys* asiae (Bonaparte, 1856) (Galliformes: Phasiandidae) from North-west Himalaya. *J. Asia Pac. Biodiv.*, **13**: 162–168. https://doi.org/10.1016/j.japb.2020.02.001

Kylanpaa, J.U.H.A., 2000. Birds of Dera Ismail Khan district of North West Frontier Province in Pakistan. *Forktail*, **16**: 15–28.

Lepage, D., 2024. *Checklist of the birds of Bannu.* Avibase, the world bird database. Retrieved from https://avibase.bsc-eoc.org/checklist.jsp?lang=EN&region=pknwbn&list=howardmoore&ref=l_asi_pk [2024–09–11].

Mahmood, T., Shah, S.M.A., Rais, M. and Nadeem, M.S., 2011. An investigation of animal species trade at pet shops of Rawalpindi and Multan cities. *J. Anim. Pl. Sci.*, **21**: 822–829.

Margalef, R., 1958. Information theory in ecology. *Gen. Syst.*, **3**: 36–71.

McGraw–Hill, C., 2008. *Statistix 8.1; Analytical software*. Tallahassee, Florida Maurice/Thomas text. ISBN: 0073402818.

McIntosh, R.P., 1967. An index of diversity and the relations of certain concepts to diversity. *Ecology*, **48**: 115–1126. https://doi.org/10.2307/1932674

Moreby, S.J., Aebischer, N.J. and Southwa, S., 2006. Food preferences of grey partridge chicks, *Predix predix*, in relation to size, colour and movement of insect prey. *Anim. Behav.*, **71**: 871– 878. https://doi.org/10.1016/j.anbehav.2005.06.017

Morrison, L.W. and Peitz, D.G., 2020. Spacing of point counts for grassland bird survey in small geographical areas: Biases and tradeoffs. *Wilson J. Ornithol.*, **132**: 810–819. https://doi.org/10.1676/19-00117

Naseer, M. and Inayat–Ur–Rehman, S.K., 2019. Diversity of avian fauna in frdarzinda, including their importance, extinction and their safety measures, in Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan. *Int. J. Res.*, **6**: 22–37.

National Geographic, 2024. *Partridges*. Web accessed on 22nd October, 2024 at URL: https://www.nationalgeographic.com//animals/birds/facts/partridges.

Ong–In, T., Pierce, A., Gale, G., Browne, S.J. and Savini, T., 2016. Nesting ecology and nest site selection of green–legged partridge. *Raffles Bull. Zool.*, **64**: 89–97.

Pandian, M., 2021. Studies on habitats of Grey Francolin *Francolinus pondicerianus* (J.F. Gmelin, 1789) (Galliformes: Phasiandae) in northern district of Tamil Nadu, India. *J. Threat. Taxa*, **13**: https://doi.org/10.11609/jott.6237.13.13.19948-19955

Potts, G.R., 1986. *The partridge, pesticides, predation and conservation*. Sheridan House Inc; Collins, London. First Edition. pp. 288. ISBN: 9780003832983.

Qadeer, S., Ejaz, R., Husna, A.U., Azam, A. and Khan, M.A., 2022. Breeding potential of Pakistan's national bird Chukar partridge: Captivity vs natural habitat. *RADS J. Biol. Res. appl. Sci.*, **13**: 70–75.

Robert, T.J., 1991. *The birds of Pakistan*. Vol. I. Regional studies and non–passeriformes. Oxford Univ Press, Karachi Pakistan. pp. 598–109.

Santilli, F., Galardi, L. and Bagliacca, M., 2012. First

evaluation of different captive rearing techniques for the re–establishment of the red legged partridge populations. *Avian Biol. Res*., **5**: 147–153. https://doi.org/10.3184/175815512X13441821968945

Scholl, E.M., Eschberger–Friedl, A., Schai–Braun, S. and Frey–Roos, A., 2023. Habitat preferences and similarities of grey partridges and common pheasants in agriculture landscapes under organic and conventional farming. *Eur. J. Wildl. Res*., **69**: 29. https://doi.org/10.1007/s10344-023-01659-1

Shannon, C.E., 1948. A mathematical theory of communication. *Bell Syst. Tech. J*., **27**: 379–423. https://doi.org/10.1002/j.1538-7305.1948.tb01338.x

Sokos, C.K., Birtsas, P.K. and Tsachalidis, E.P., 2008. The aims of galliformes release and choice of techniques. *Wildl. Biol*., **14**: 412–422. https://doi.org/10.2981/0909-6396-14.4.412

Taylor, R.L., Maxwell, B.D. and Boik, R.J., 2006. Indirect effects of herbicides on bird food resources and beneficial arthropods. *Agric. Ecosyst. Environ*., **116**: 157–164. https://doi.org/10.1016/j.agee.2006.01.012

Thomas, L., Buckland, S.T., Rexstad, E.A., Laake, J.L., Strindberg, S., Hedley, S.L., Bishop, J.R.B., Marques, T.A. and Burnham, K.P., 2010. Distance software: design and analysis of distance sampling surveys for estimating population size. *J. Appl. Ecol.,* **47**: 5–14. https://doi.org/10.1111/j.1365-2664.2009.01737.x

Van Vliet, N., Moreno, J., Gomez, J., Zhou, W., Fa, J.E., Goldern, C., Nobrega Alves, R.P. and Nasi, R., 2017. Bushmeat and human health: Assessing the evidence in tropical and sub-tropical forests. *Ethnobiol. Conserv*., **6**: 3. https://doi.org/10.15451/ec2017-04-6.3-1-45

Vargas, J.M., Guerrero, J.C., Farfán, M.A., Barbosa, A.M. and Real, R., 2006. Land use and environmental factors affecting red–legged partridge (*Alectoris rufa*) hunting yields in southern Spain. *Eur. J. Wildl. Res*., **52**: 188–195. https://doi.org/10.1007/s10344-006-0028-4

Viana, D.S., Gangoso, L., Bouten, W. and Figuerola, J., 2016. Overseas seed dispersal by migratory birds. *Proc. R. Soc. B*, **283**: 20152406. https://doi.org/10.1098/rspb.2015.2406

Vitula, F., Peckova, L., Badouchova, H., Pohanka, M., Novotny, L., Jira, L., Kral, J., Ondracek, K., Osickova, J., Rosenbergova, K., Treml, F. and Pikula, J., 2011. *Mycoplasma gallisepticum* infection in grey partridge *Perdix perdix*: outbreak description, histopathology, biochemistry and antioxidant parameters. *BMC Vet. Res*., **7**: 34. https://doi.org/10.1186/1746-6148-7-34

Volpato, G.H., Lopes, E.V., Mendonca, L.B., Bocon, R., Bisheimer, M.V., Serafini, P.P. and dos Anjos, L., 2009. The use of the point count method for bird survey in the Atlantic forest. *Zoologia*, **26**: 74–78. https://doi.org/10.1590/S1984-46702009000100012

Weir, J.E.S. and Corlett, R.T., 2007. How far do birds disperse seeds in degraded tropical landscape of Hong Kong, China? *Landsc. Ecol*., **22**: 131–140. https://doi.org/10.1007/s10980-006-9002-5

Whelan, C.J., Wenny, D.G. and Marquis, R.J., 2008. Ecosystem services provided by birds. *Annls N. Y. Acad. Sci*., **1134**: 25–60. https://doi.org/10.1196/annals.1439.003