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## Comparative Ecology of Black Francolin (*Francolinus francolinus*), Grey Francolin (*Francolinus pondicerianus*) and Chukar Partridge (*Alectoris chukar*) in Swegalai Game Reserve, Swat, Khyber Pakhtunkhwa, Pakistan

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Animals select resources for food, cover and nest sites. If a variety of habitats are available to an animal, it selects some and avoids others. We compared habitat preferences of three species of the order Galliformes, Black francolin, Grey francolin and Chukar partridge in Swegalai Game Reserve in district Swat Khyber Pakhtunkhwa Province of Pakistan during June 2007. We observed 75 Black francolins, 58 Grey francolins and 146 of Chukar partridges. Black francolins were observed singly or in pairs; Grey francolin in small groups and Chukar in larger groups of up to 13 birds. Six habitat types were identified in the reserve and were mapped using GIS and field surveys. Black francolin and Grey francolin were distributed in three of the of the available six habitat types: woody ravines, shrub land and agricultural fields. Chukar partridge occurred five out of six: agricultural fields, shrub lands, mountain slopes, grass lands and barren rocks. Chi-square tests showed that each species displayed significant habitat selection in relation to the availability Black francolin and Grey francolin had selected broadly similar habitats and showed highly significant preference for woody ravines. By contrast Chukar partridge preferred mountain slopes highly significantly and avoided woody ravines completely. All the three species preferred northerly aspects and foraged in the morning and evening, interpreted as a strategy to reduce heat stress in summer. We reviewed record of the Khyber Pakhtunkhwa Wildlife Department Pakistan pertaining to population of all the three species include Black francolin, Grey francolin and Chukar partridge from 2010 to 2019 and revenue generated in the last ten years from 2010-11 to 2019-2020. It was found that highest total population of Black, Grey francolin and chukar partridge was observed in 2014 with 586 followed by 2012 (570) and 2013 (545) while the population in the remaining years ranged between 188-336. A fluctuated population trend was observed during the period. The gross revenue of Rs. 663300 was generated by hunting of 1284 all the three species include Black francolin, Grey francolin and Chukar partridge through issuance of 198 permits. The community of the reserve was paid Rs. 596970 as their 90% share and the government retained Rs. 66330 as 10% share out of the total revenue generated.

**Keywords:** Comparative ecology, Black Grey francolins and Chukar partridge, Swegalai, District Swat

### INTRODUCTION

The Black francolin, Grey francolin and Chukar partridge belong to the Kingdom Animalia; Phylum

Chordata; Class Aves; Order Galliformes; Family Phasianidae. Black and Grey francolin have a large range, with an estimated global extent of

occurrence of 1,000,000–10,000,000 km<sup>2</sup>. It has a large global population, including an estimated 12,000–36,000 individual in Europe. Global population trends have not been quantified, but populations appear to be stable (Del Hoyo et al. 1994) so the species are not believed to approach the thresholds for the population decline criterion of the IUCN Red List (i.e., declining more than 30% in ten years or three generations). For these reasons, the species is evaluated as Least Concern It is found in Afghanistan, Armenia, Azerbaijan, Bangladesh, Bhutan, Cyprus, Georgia, Guam, India, Iran, Iraq, Israel, Italy, Jordan, Lebanon, Nepal, Pakistan, Palestine, Portugal, Saudi Arabia, Spain, Syria, Turkey, Turkmenistan, and an introduced population in United States (Birdlife International 2004). In Pakistan they occupy Mediterranean-type Shrubby Vegetation, grasslands, open, grassy brush lands and cultivation from semi deserts riverain valleys to openings adjacent to forested areas. Not a forest or true deserts inhabitant. Occurs from sea level to 750 m, on flat, rolling hilly terrain. Soil varies from desert sandy clay in drier habitats to alluvial loam in river valleys to mountain forest soils in hilly region (Roberts 1991). They are found in dry to semi-deserts grasslands and scrub to fairly well watered pastures and cultivation. Grey francolin occupies the widest range of dry habitats. Absent in bare treeless or shrub less deserts, swampy grounds, dense forests steep terrain and humid tracts. Common from sea level up to 600 m, occasionally to 1400 m. Topographically Grey francolin occurs in flat to rolling habitat with hilly country avoided. Soil varies from sandy deserts, reddish prairie or black gray of wet-dry subtropics to sandy alluvial (Roberts 1991).

Fourteen subspecies of *Alectoris chukar* are currently recognized. The native distribution ranges across mountainous areas of the Middle East and Asia from eastern Greece and southeastern Bulgaria through Asia Minor east to Manchuria China (Del Hoyo 1994). *Alectoris chukar* are not globally threatened. In most areas, populations are stable or increasing, though habitat loss and intensive hunting may affect some local populations in their native distribution (Del Hoyo 1994). The Chukar is eminently a mountain partridge living on barren rocky slopes, and ravines, sparsely dotted with stunted grass and bushes. In winter it comes down to elevations of 1200-1500 m but descends with the advance of summer to 2500 m. It commonly keeps to the neighborhood of terraced wheat fields on the hillsides, and also works its way down to feed in the

cultivated mountain valley. Parties of four are birds are usually met with, but coveys of up to fifty and more are not uncommon in late autumn (Roberts, 1991). Sufficient amounts of utilizable resources are needed to meet with animal population. Therefore, biologists often identify resources used by animals and document the availability of those resources. The need for such documentation is critical in efforts to preserve endangered species and manage exploited populations. Determining which resources are selected more than others is of particular interest because it provides fundamental information about the nature of animals and how they meet their requirements for survival. Differential resource selection is one of the principal relationships, which permit species to co-exist (Rozenzweig 1981). It is often assumed that a species will select a resource that is best able to satisfy its life requirements and that high-quality resources will be selected rather than low quality ones (Manly et al. 1993). If variety of habitats are available to an animal, it uses certain and avoids others (Krebs, 1999). However, many factors, including population density, competition with other species, natural selection, the chemical composition or texture of forage, heredity, and predation contribute to resource selection. Although the reason why a particular resource is selected or avoided is not directly revealed by the estimation of use or avoidance, however, by learning that there is selection for or against a resource, then this could be used as a starting point for further in-depth study (Petrides, 1975). Among the game bird species in Pakistan, three of the most widely distributed are the Black francolin Gray francolin and the Chukar partridge. Encroachment into marginal lands for agriculture, human settlements the use of mechanized farming, pesticides and unregulated hunting are the main causes of decline of the population. However, the true picture of their population decline is unknown and the precise causes remains un-investigated (Khan, 1999). To achieve a better understanding of the habitat selection we examined the comparative ecology of Black francolin, Grey francolin and Chukar partridge in Swegalai Game Reserve in June 2007.

## MATERIALS AND METHODS

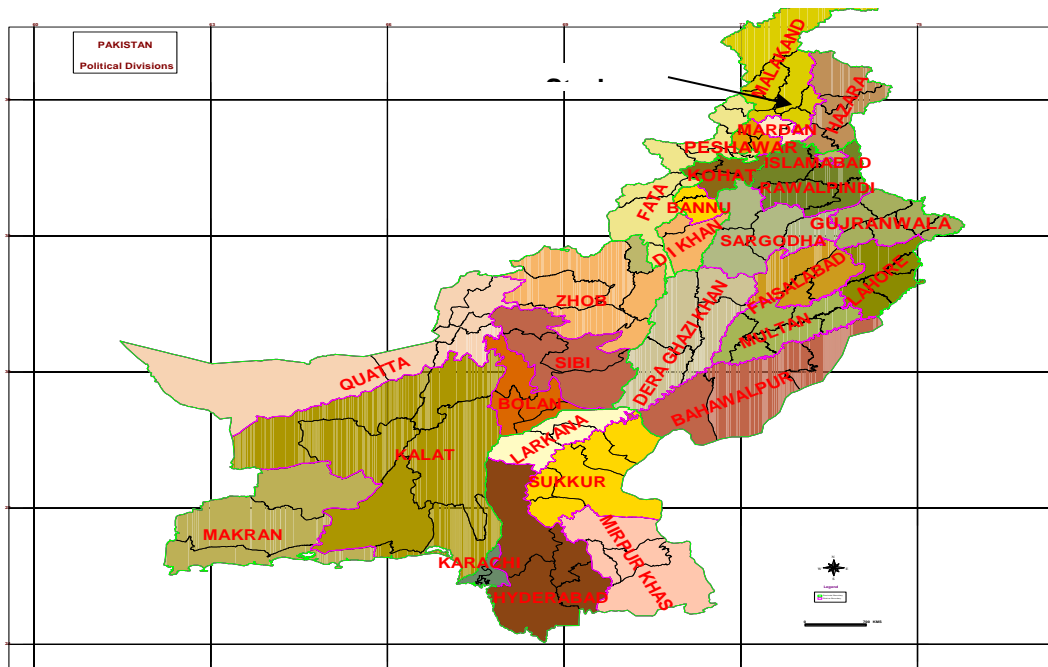
### Study area

The area was selected for the study because the Government of Khyber Pakhtunkhwa notified the area as Swegalai Game Reserve since 1984 with an area of 1820 Hectares on October 10,

1984. The game reserve is of historical and national importance. The Khyber Pakhtunkhwa Wildlife Department manages the area and hunting is allowed only in the prescribed shooting season through special permits. The study area is situated in the district Swat of the Khyber Pakhtunkhwa of Pakistan. Geographically, Swat lies from 34°-34' to 35°-55' North latitudes and 72°-08' to 72°-50' East longitudes with an area of 5337 km<sup>2</sup>. The District boundaries cover, the North by central District and Ghizer District of Northern Areas, on the east by Shangla and Kohistan, on the South by Buner and Malakand Protected Area and on the West by the lower and upper Dir Districts. The present work is confined to Swegalai Game Reserve Swat, located at the north of Khyber Pakhtunkhwa, Pakistan. The area is located between 72°-15' East to 72°-11' west longitude and 34°-46' North to 34°-42' south Latitude. The boundaries of the Swegalai game reserve are, ridge separating the watershed of Kotali Khwar, ridge separating the watershed of Parrai sub stream in the south, Dadahar stream and Gdau village in east and ridge separating the watershed of Jolgaran Khwar, Rangila Shamoza valley (fig-1).

**Methods**

The main method for collecting data for the target species was line transects. Line transects were selected randomly and duration of the survey was from 06h00-20h00 each survey day. A total of 12 transects were selected, varying from 2.02 to 5.43 km in length and thus the whole study area was covered. In order to maximize the detection of the target species two assistants were used, one each side of the author. Each assistant also had a trained pointer dog to flush the birds. Therefore, each transect was 200 meters wide, as suggested by Bibby et al. (1992) and it was assumed that all birds had the same chance of being sighted within the 200 m wide transect strip. For each sighting, a series of habitat parameters were recorded. These were: habitat type, elevation, aspect, and distance to nearest water source (springs or rain fed pool). The study area was divided into six major habitat types based on physical features and vegetation characteristics: agricultural fields, woody ravines, mountain slopes, shrub land, barren rocks, and grasslands.



**Figure 1: Map of Pakistan showing the political divisions and location of the study area**

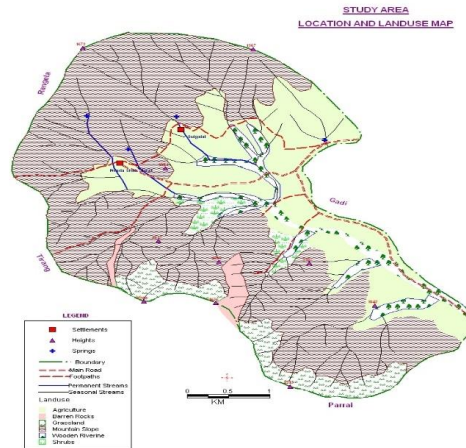


Figure 2: Showing location and land use map of the study area

The mapping of the study area was based on Topographic maps Survey of Pakistan, G.T.Sheet No 43 B/1, 43 B/2, 43 B/5 and 43 B/6 having scale 1:50 k published by survey of Pakistan 2001.the layers have been extracted from the raster images using MapInfo Vs 8.1 with the help of Geographical information Technology. Maps were updated from SUPARCO satellite images and habitat boundaries were mapped on layers using the satellite data and ground-truthed by field survey using Geographical Positioning System (GPS). Figure 2 shows Swegalai Game Reserve and the main habitats.

**Statistical analysis.**

Chi square test was used for statistical analysis of the data at the value to alpha set at 0.05 (the level of significance) was used. The test statistic used is:

$$\chi^2 = \sum_{i=1}^r \sum_{j=1}^c \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

Where  $O_{ij}$  is the observed number of observations and  $E_{ij}$  is the expected number of observations and can be calculated as:

$$E_{ij} = \frac{A_i B_j}{N}$$

In addition, Standard Deviation of various parameters was calculated as:

$$\bar{X} = \frac{\sum X_i}{n} \quad \text{And s.d} = \sqrt{\frac{\sum (X_i - \bar{X})^2}{n-1}}$$

**RESULTS**

**Transects and area**

Table-1 and fig-3 shows that a total of 12 transect were navigated, totaling 44.8km. Mean transect length was 3.73 km (SD = 1.063). The average area covered in a single day was 0.74 sq km.

**Occurrence of plants**

We identified nineteen (19) plant species (table-2) and eight (8) grass species (table-3) from the study area.

**Birds observed**

Table-4 reveals that a total of 75 Black francolins, 58 Grey Francolins and 146 Chukar Partridges were observed singly, in pairs and family groups in the study area.

**Species and group size**

Figure 4 shows the group sizes observed in each of the three species. Black francolins were only found singly or in pairs. 63 out of 75 Black francolin were observed singly and only 12 in pairs. Grey francolin had a group size range of 2-6 birds. Chukar partridge occurred in groups from 2 to 13 birds, 114 out of a total of 146 birds were in coveys of 6 or more.

**Species and aspects**

Table 5 shows the use of different aspects by each of the target species. Northerly aspects (representing 37.5% of the available) were preferred by all species: Black francolin (75%), Grey francolin (91%) and Chukar partridge (71%).

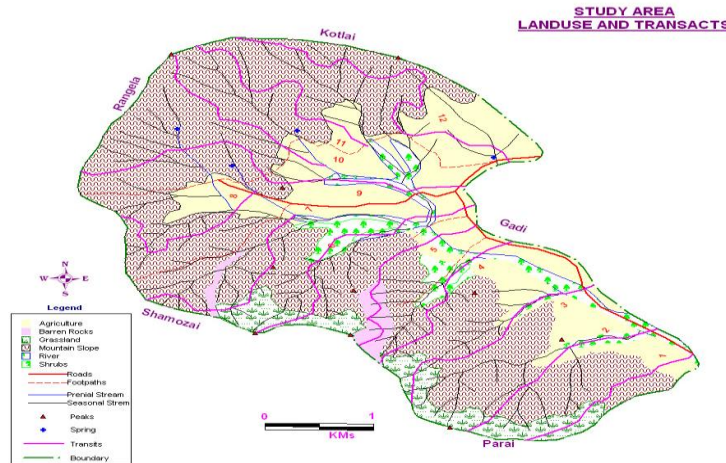


Figure 3: Location of transects on the map

Table-1: Number of transects traversed and area covered in Swagali Game Reserve

Transect Number	Transect length (km)	Number of days	Area calculated (ha)
1	5.43	1	109
2	4.36	1	87.2
3	4.74	1	94.8
4	3.1	1	61
5	4.89	1	97.8
6	3.07	1	61.4
7	3.65	1	73
8	2.02	1	40.4
9	3.99	1	79.8
10	4.12	1	82.4
11	3.32	1	66.4
12	2.11	1	42.2
Total	44.8	12	895.4

Table-2: Plant species identified in Swagali Game Reserve

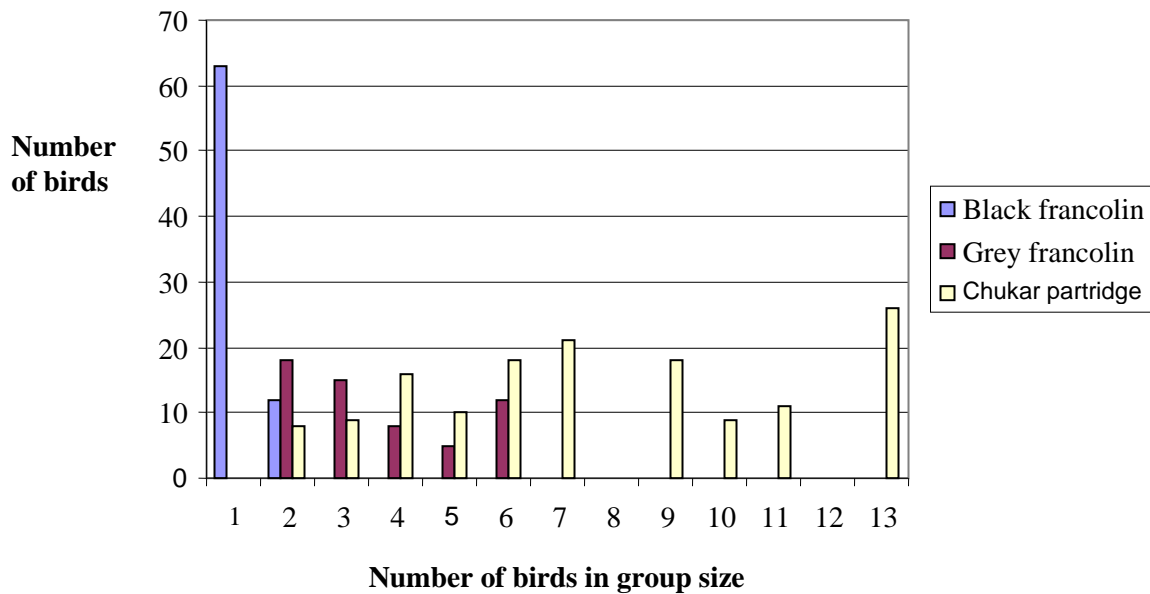
S. N	English name	Scientific name	Family
1	Cotoneaster	<i>Cotoneaster microphyllus</i> wall.ex.Lind.	Rosaceae.
2	Dock sorrel	<i>Rumax hastatus</i> D. Don.	Polygonaceae
3	Switch sorrel	<i>Dodonea viscosa</i> L.Jacq.	Sapindaceae.
4	Silk worm	<i>Periploca aphylla</i> K Decene.	Asclpiadaceae.
5	Germander	<i>Teucrium stocksianum</i> Boiss.	Lamiaceae.
6	Oleander	<i>Nerium oleander</i> L.	Apocynaceae.
7	Black berry	<i>Rubus fruticosus</i> Agg.	Rosaceae
8	Rhus	<i>Rhus cotinus</i> L.	Anacardiaceae
9	Indigo	<i>Indigofera heterantha</i> wall.Bth	Paplionaceae.
10	Malbarnut	<i>Justica adhatoda</i> L.	Acanthaceae
11	Wild Grape	<i>Vitis jacquemontii</i> .	Vitaceae.
12	Jujuba.	<i>Zizyphus oxyphylla</i> Edgeo.	Phamnaceae.
13	-	<i>Otostegia limbata</i> Boiss.	Lamiaceae
14	Meadow plant	<i>Limonium gelsii</i>	Plumbaginaceae
15	Myrtle	<i>Myrtus communis</i> L.	Myrtaceae.
16	Olive.	<i>Olea ferruginea</i> Royle.	Oleaceae.
17	Bugle	<i>Ajuga parviflora</i>	Liniaceae
18	Nettle tree.	<i>Celtis australis</i> L.	Ulmaceae.
19	Fig	<i>Ficus palmata</i> forssk.	Moraceae

**Table 3: Grass species identified in Swegalai Game Reserve**

Sl.#	Scientific name	Family name
1.	<i>Cynodon dactylon</i> (L) Pers.	Poaceae
2.	<i>Dactyloctenium glumerata</i> Linn	Poaceae
3.	<i>Sorghum halpense</i> (L) Pers	Poaceae
4.	<i>Imperata Cylindrica</i> (L) Raeu	Poaceae
5.	<i>Aristida cynantha</i> Nees ex.Steud.	Poaceae
6.	<i>Aristida mutabilis</i> Trin & Ruper.	Poaceae
7.	<i>Apluda mutica</i> Linn	Poaceae
8.	<i>Hetropogan contortus</i> (L) Bea.exRoem & Schul	Poaceae
9.	<i>Dactyloctenium aegyptium</i> (L) Wild	Poaceae

**Table-4: Number of Black francolin, Grey francolin and Chukar partridge in Swegalai game reserve.**

Black francolin			Grey francolin			Chukar partridge
Male	Female	Total	Male	Female	Total	Male & female of the same colors.
48	27	75	27	31	58	146



**Figure-4: Black francolin, Grey francolin and Chukar group sizes and frequency of occurrence**

**Table-5: Number of Chukar partridge, Black and Grey francolins recorded on different aspects in Swegalai Game Reserve.**

Aspect	Black francolin (n = 75)		Grey francolin (n =58)		Chukar Partridge (n=146)	
	Observed	%	Observed	%	Observed	%
North	33	45	19	32	31	21
North East	13	17	16	28	32	22
North West	10	13	18	31	40	28
South	00	00	00	00	00	00
South East	00	00	00	00	13	9
South West	00	00	00	00	06	4
East	10	13	00	00	15	10
West	09	12	05	9	09	6

By contrast, Black and Grey francolin were not recorded on southerly aspects at all and only 13 % of Chukar were recorded on southerly aspects. Fig-4 shows use by the three species of the four main aspects (northerly, southerly, easterly, westerly).

#### Species and habitat utilization

Table 6 shows, the use of the six habitats by each species in relation to their availability. Black francolin and Grey francolin were both observed in only three out of the six habitats: these were agricultural fields, woody ravines, and shrub lands. Chukar used five out of six habitats. They avoided woody ravines, but also used mountain slopes, grass lands and barren rocks. Black francolin showed a strong preference for woody ravines (56% of birds in 15% of the study area). Grey francolin also preferred woody ravines (46% of birds in the 15% of the study area). Chukar partridge preferred mountain slopes (44% of birds in 27% of the study area). Overall, Black francolin and Grey francolin showed similar habitat preferences. Chukar showed quite clear habitat separation from the other two species, although they all overlapped to some extent in agricultural fields and shrub lands.

The data show that the target species all select/prefer some habitats and avoid others. The Chi- square test shows the use of the six habitats by each species in relation to their availability that in each case, the three species highly significantly prefer the habitats. The habitats preference showed by Black francolin ( $\chi^2 = 120.71$ ,  $p < 0.001$ ); Grey francolin ( $\chi^2 = 74.45$ ,  $p < 0.001$ ) and Chukar partridge ( $\chi^2 = 37.41$ ,  $p < 0.001$ ) were highly significant. The Black francolin ( $\chi^2 = 84$ ,  $p < 0.001$ ) showed highly significant preferences for woody ravines and Grey francolin ( $\chi^2 = 38.49$ ,  $p < 0.001$ ) also showed highly significant preference for

woody ravines. By contrast Chukar partridge ( $\chi^2 = 15.32$ ,  $p < 0.001$ ) showed highly significant preference for mountain slopes habitat.

#### Proximity of species to water sources

The proximity of each bird or group of birds to nearest water source (springs or rain-fed pool) was also calculated. These distances were classified into five distance classes (Table 7). The table shows that Black francolin was the most closely associated with a water source and 47% of birds observed occurred within 0-25 meters of water. By contrast 55% of Grey francolins were within 75-100 meters of a water source. Chukar partridge were least associated with water, with 69% of birds observed over 100 meters distant from a water source.

#### Species and time

Table 8 show the time of day in two-hour periods when the target species were observed. All species were observed throughout the day but most were recorded in the morning between 06h00 and 10h00: Black francolin – 54%, Grey francolin – 46% and Chukar 45%. The highest percentages of Chukar partridge was recorded in the morning (52%) and evening (32%) Black francolin in the morning (65%) and evening (20%) and Grey francolin in the morning (66%) but by contrast to the high percentages of Chukar partridge and Black francolin in the evening the percentage was low (12 %) and was high in the midafternoon (22%).

#### Population

We also reviewed the population of Black, Grey francolins and Chukar partridge in Swegalai Game reserve from record of the Khyber Pakhtunkhwa Wildlife Department for the last ten years during 2010 to 2019 (table-9). It was found that highest total population of Black, Grey

francolin and chukar partridge was observed in 2014 with 586 followed by 2012 (570) and 2013 (545) while the population in the remaining years ranged between 188-336. Chukar partridge was the dominant species among all the three species with highest population ranged between 110-394 followed by Black francolin with 22-115 and Grey francolin with 3-85 during the last ten years in 2010 to 2019. A fluctuated population trend among all the three species was observed during the period.

**Revenue**

We also reviewed record of the Khyber Pakhtunkhwa Wildlife Department pertaining to the total number of Black, Grey francolins and Chukar partridge hunted and revenue generated in Swegalai Game reserve in the last ten years during 2010-11 to 2019-20 (table-10). It was found that a total of 1284 birds include Black, Grey francolins and Chukar partridge were hunted by issuance of

198 permits and a gross revenue of Rs. 663300 was generated, out of which Rs. 596970 was paid to the community as their 90% share and Rs. 66330 as 10 % share was retained by the government as per government of policy. High revenue was generated during the year 2013-14 (Rs. 217750) with estimated 422 Black, Grey and chukar partridges hunted by issuance of 65 permits followed by 2018-19 with Rs.117250 with estimated 277 Black, Grey and chukar partridges hunted by issuance of 35 permits and 2019-20 with Rs. 107200 with estimated 208 Black, Grey and chukar partridges hunted by issuance of 32 permits while the revenue ranged between Rs. 10050-Rs.97150 in the remaining years with estimated 19-188 Black, Grey and chukar partridges hunted by issuance of permits ranged between 3-29. The average bag limit bag limit (Number birds hunted per gun per day) remained as 6.5 and the average permit fee as Rs. 3350.

**Table-6: Percent use of Black, Grey francolins and Chukar partridge in various habitat types of Swegalai Game reserve.**

Habitats Type	Area (Hectares)	% area	Black francolin		Grey francolin		Chukar partridge	
			No. of birds	% Birds	Observed	% Birds	Observed	%
Agric: field	450	17	17	23	16	28	25	17
Woody ravines	405	15	42	56	27	46	00	00
Shrub lands	395	15	16	21	15	26	21	14
Mountain slopes	715	27	00	00	00	00	64	44
Grass lands	360	14	00	00	00	00	19	13
Barren rocks	320	12	00	00	00	00	17	12

**Table-7: Black francolin, Grey francolin and Chukar partridge to water sources.**

Distance (meters)	Black francolin		Grey francolin		Chukar partridge	
	Number	%	Number	%	Number	%
0-25	35	47	00	00	00	00
25-50	24	32	6	10	00	00
50-75	10	13	13	23	25	17
75-100	6	8	32	55	21	14
>100	00	00	7	12	100	69



**Table-8: Black francolin, Grey francolins and Chukar partridge observed through the day in Swegalai Game Reserve.**

Sighting time of birds	Black francolin. (n= 75)		Grey francolin (n= 58)		Chukar Partridge. (n= 146)	
	Observed	%	Observed	%	Observed	%
06h00-08h00	22	30	18	30	41	29
08h00-10h00	18	24	9	16	24	16
10h00-12h00	9	12	11	19	10	7
12h00-14h00	4	5	8	14	16	11
14h00-16h00	7	9	5	9	8	5
16h00-18h00	11	15	4	7	35	24
18h00-20h00	4	5	3	5	12	8

**Table-9: Population trend of Black, Grey francolins and Chukar partridge in Swegalai Game reserve during the last 10 years in 2010 to 2019**

Year	Black francolin	Grey francolin	Chukar partridge	Total
2010	22	3	212	237
2011	63	15	258	336
2012	94	82	394	570
2013	109	76	360	545
2014	115	85	386	586
2015	60	65	110	235
2016	50	18	120	188
2017	52	29	117	198
2018	62	23	206	291
2019	66	32	182	280

**Table-10: Total number of Black, Grey francolins and Chukar partridge hunted and revenue generated in Swegalai Game reserve during the last 10 years in 2010-11 to 2019-20**

Year	Hunting permits	Average Permit fee	Revenue Generated (Rs)	Average bag limit	Total estimated birds hunted	Estimated Community share 90%	Estimated Govt: share 10%
2010-11	15	Rs. 3350	50250	6.5	97	45225	5025
2011-12	00		00		00		
2012-13	00		00		00		
2013-14	65		217750		422	195975	21775
2014-15	00		00		00		
2015-16	19		63650		123	57285	6365
2016-17	3		10050		19	9045	1005
2017-18	29		97150		188	87435	9715
2018-19	35		117250		227	105525	11725
2019-20	32		107200		208	96480	10720
Total	198	663300	1284	596970	66330		

**DISCUSSION**

**Occurrence of plants**

Plants play a vital role in food web (Cagnolo, et al. 2009) and reveal the stability and ecosystem function (Bukovinszky, et al. 2008). The plants are used as hiding places and the canopy cover is used by animals including birds for resting places (Deanw, et al. 1999). The animals including birds utilize parts of plants as food but they also pose

biochemical and adaptive physiological responses to lack of food (Wang, et al. 2006). We identified and recorded nineteen (19) plant species (table-2) and eight (8) grass species (table-3) from the study area.

**Habitats**

The agricultural fields lying adjacent to the mountain are rain-fed, rainfall is very critical in Swagali Game Reserve, wheat is raised that is

harvested till end of May, and thus these fields remain barren till the next sowing season in October, each field has shrubby vegetation on its boundary. During crop harvesting, the maize grains fell in the fields which are available for birds as feed. All the three species use agricultural fields. The results showed that the target species all displayed a significant degree of habitat selection. The main points of comparison between the three target species were as follows. Chukar partridge use five out of the six habitats and significantly prefer mountain slopes; they avoid completely the woody ravines. They are clearly separated from the other two species on the basis of habitat. In summary, Black francolin and Grey francolin use cover habitats while Chukar partridge prefer more habitat types. The other two species, Black francolin and Grey francolin, showed a significant preference for woody ravines. Black francolin and Grey francolin use the same three out of the six habitats in the reserve in approximately the same proportions. They both avoid completely the mountain slopes, barren rocks, and grass lands. However, once the distance from water is examined, some differences emerge. Black francolin was consistently recorded closer to water sources, with almost half sightings within 25m and only 8% between 75 and 100m. to Grey Francolin. This apparent preference for a sub-habitat type explains how two species of similar size can share the same habitat. By contrast, Chukar partridge was found at greater distances from water sources, this is consistent for their preference for mountain slope habitat. A further indication of the tolerance by Chukar partridge of dry habitats is that this was the only one of the three species to be recorded on southerly aspects. Numerous authors also conducted similar research on habitat include Ali and Ripley 1969; Roberts 1991; Khan 1999; Madge and McGowan 2002; De Graaf et al 1991, Johnsgard 1973; Leopold et al 1981; Sibley et al 1990; Walter 2000; Yocom 1943; and Christensen 1996.

### Aspects

All species were recorded most frequently on the northerly aspects (71% of the Chukar, 75% of Black francolin and 91% of the Grey francolin). This can be straightforwardly explained by several factors: reduced solar radiation results in cooler conditions, reduced heat stress in summer; increased moisture on northerly slopes promotes better vegetation growth and foraging conditions; The birds will seek to minimize the effects of heat stress by foraging early morning/evening as above

and on shaded aspects.

### Time

More than 2/3<sup>rd</sup> population of each of the three target species Black francolins, Grey francolin and Chukar partridge was sighted foraging in the morning and evening, however Grey francolin showed a slight drag towards midafternoon. The maximum temperature of the study area registered during the field work was 35°C in the mid-afternoon so this behavior is also clearly connected with the need to reduce heat stress. The maximum number of Black francolin was recorded singly or in pairs and Grey francolin in pairs or in family group of six birds. By contrast Chukar partridge in group size of thirteen birds. This shows that Black francolins were solitary or in mated pairs, Grey francolins were in family parties and Chukar partridges were in flocks. These findings conform broadly to those of Campbell and Lack, 1985; Delacour Amadon, 1973; Johnsgard, 1999; Jones et al 1995; Weigand 1980; Madge and McGowan, 2002 that Some Galliformes are solitary while others spend some part of the year in mated pairs or in flocks. It is possible that species living in open habitats, like Chukar, can forage more effectively in groups and have an advantage in detecting predators, but in closed habitats there is less advantage in foraging in groups.

### Population

A fluctuated population trend was observed during the period 2010-2019. The highest total population of Black, Grey francolin and chukar partridge was observed in 2014 with 586 followed by 2012 (570) and 2013 (545) while the population in the remaining years ranged between 188-336

### Revenue

A gross revenue of Rs. 663300 was generated during 2010-11 to 2019-20 by hunting of 1284 all the three species include Black francolin, Grey francolin and Chukar partridge through issuance of 198 permits. The community of the reserve was paid Rs. 596970 as their 90% share and the government retained Rs. 66330 as 10% share out of the total revenue generated.

### CONCLUSION

All the three target species show habitat selection. Black francolin and Grey francolin prefer woody ravines. In contrast to Black francolin and Grey francolins, Chukar partridge prefer mountain slopes and avoid woody ravines, this could attract natural resource managers to plan conservation

interventions for the study species in the preferred habitats and might be magnetize the policy makers to devise policies pertaining to agriculture, study species and their habitats to mitigate encroachment into marginal lands for agriculture, human settlements in the species habitats, the use of mechanized farming, pesticides and unregulated hunting. Black francolin prefer habitat at the nearest distance to water source, Grey francolin prefer habitats that are comparatively dry than the Black francolin habitats and by contrast Chukar partridge prefer habitats drier than the two francolin species. This can contribute to species habitat improvement practices. The three species Black francolin, Grey francolin and Chukar partridge prefer northerly aspects and foraging in the morning and evening to reduce heat stress in summer, further studies are needed to investigate aspects preferences and foraging time of the study species in winter so that management interventions could be planned accordingly. Black francolin forage in large group of two birds, Grey francolin of six birds and Chukar partridge of 13 birds, might be an anti-predator strategy to forage in groups. This can encourage species behavioral studies. In review of the reviewed of the record Khyber Pakhtunkhwa Wildlife Department Pakistan pertaining to population of all the three species include Black francolin, Grey francolin and Chukar partridge in 2010 to 2019 and revenue generated in the last ten years in 2010-11 to 2019-2020. It was found that highest total population of Black, Grey francolin and chukar partridge was observed in 2014 with 586 followed by 2012 (570) and 2013 (545) while the population in the remaining years ranged between 188-336. The gross revenue of Rs. 663300 was generated by hunting of 1284 all the three species include Black francolin, Grey francolin and Chukar partridge through issuance of 198 permits. The community of the reserve was paid Rs. 596970 as their 90% share and the government retained Rs. 66330 as 10% share out of the total revenue generated.

The results of this study can contribute to studies on population dynamics of the study species; modeling and projecting the impact of habitat change on species population; identifying key areas for protection; assessment of the effects of resource use like livestock grazing, grass cutting etc on wild populations, planning and policy decisions for habitat management and harvest levels.

#### CONFLICT OF INTEREST

The authors declared that present study was

performed in absence of any conflict of interest.

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#### AUTHOR CONTRIBUTIONS

SFBK fully contributed in all aspects of the study.

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#### REFERENCES

- Ali S, Ripley AD (1969). Handbook of the Birds of India and Pakistan, together with those of Nepal, Sikkim, Bhutan and Ceylon, Vol.2. Oxford university press, Bombay.
- Bibby C. J., Burgess, N. D. and Hill, D.A (1992) Bird Census Techniques Academic Press, London, U.K.
- Birdlife International (2004). *Alectoris chukar*. In: IUCN 2006. 2006 IUCN Red List of Threatened Species.
- Birdlife International (2004). *Francolinus francolinus*. In: IUCN 2006. 2006 IUCN Red List of Threatened Species
- Bukovinszky T. F. J, Frank Y, Jongema and M. Dicke (2008). Direct and Indirect Effects of Resource Quality on Food Web Structure. *Journal of Science*. 319: 804-807.
- Cagnolo L. G, Valladares A, Salvo, M. Cabido and M. Zak (2009). Habitat Fragmentation and Species Loss across Three Interacting

- Trophic Levels: Effects of Life-History and Food-Web Traits. *Journal of Conservation Biology* 23 (5): 1167–1175.
- Campbell B, E. Lack (1985). *A Dictionary of Birds*. Vermillion: Buteo Books.
- Christensen C (1996). Chukar: *Alectoris chukar*. Pp. 1-20 in A. Poole, F. Gill, eds. *The Birds of North America* (0):258. Philadelphia, PA: The Academy of Natural Sciences of Philadelphia.
- De Graaf, Richard M, Scott Virgil E, Hamre, R. H (1991). *Forest and rangeland birds of the United States*. Natural history and habitat use.
- Dean W. R, J. S. J. Milton and F. Jeltsch (1999). Large trees, fertile islands, and birds in arid savanna. *Journal of Arid Environments* 41, 41-78.
- Del Hoyo J, A. Elliot, J. Sargatal (1994). *Alectoris Chukar*. Pp. 485-486 in *Handbook of the birds of the world, Vol. 2: New world vultures to guinea fowl*. Barcelona, Lynx Edicions.
- Delacour J, D. Amadon (1973). *Curassows and Related Birds*. New York: American Museum of Natural History.
- Johnsgard P (1999). *The Pheasants of the World Biology and Natural History*. Washington, D.C, Smithsonian Institution Press.
- Johnsgard, Paul A (1973). *Grouse and quails of North America*. Lincoln, NE: University of Nebraska Press. 553 p. [20323]
- Jones D, R. Dekker, C. Roselaar (1995). *The Megapodes*. New York: Oxford University Press Inc.
- Khan R. A (1999). *Ecology and Conservation of Francolins in Agricultural land*. PhD thesis, The University of Newcastle Upon Tyne.
- Krebs C. J (1999). *Ecological Methodology*. 2nd Edition, Addison Wesley Longman. Menlo
- Leopold A. Starker, Gutierrez, Ralph J, Bronson, Michael T (1981). *North American game birds and mammals*. New York: Charles Scribner & Sons. 198 p. [22815]
- Madge S, P. McGowan (2002). *Pheasants, Partridges and Grouse: A guide to the pheasants, partridges, quails, grouse, guineafowl, buttonquails and sandgrouse of the world*. London, Christopher Helm.
- Manly B.F.J, McDonald L.L, Thomas D.L (1993). *Resource selection by animals: Statistical design and analysis for field studies*. Chapman and Hall, London.Park, CA.
- Petrides G. A (1975). Principal foods versus preferred foods and their relations to stocking rate and range condition. *Biological Conservation* 7:161-169.
- Roberts T.J (1991). *The birds of Pakistan*. Vol. 1: Non-Passeriformes. Oxford: Oxford University Press, c1991. ISBN 0195574043.
- Roberts T.J (1991). *The birds of Pakistan*. Vol. 2: Passeriformes. Oxford: Oxford University Press, c1991. ISBN 0195774051.
- Rosenzweig M.L (1981). A theory of habitat selection. *Ecology* 62, 327-35.
- Sibley CG, Monroe BL Jr (1990). *Distribution and taxonomy of birds of the world*. Yale University Press, New Haven, ct (USA). 1111 p.[22814]
- Walter H (2000). *Ecology of the Chukar in eastern Oregon*. M.S Thesis University of Idaho Moscow, ID.
- Wang T. C, C.Y. Hung and D. J. Randall. 2006. The comparative ecology of food deprivation: from feast to famine. *Annual Review of Physiology*. 68: 223-251.
- Weigand J.P (1980). *Ecology of Hungarian partridge in north-central Montana*. *Wildlife Monographs*.74: 1-106.