

## HABITAT PREFERENCE OF GREY FRANCOLIN (*FRANCOLINUS PONDICERIANUS*) IN SALT RANGE, PUNJAB

S. Khalil<sup>1\*</sup> and M. Anwar<sup>2</sup>

<sup>1\*</sup>Department of Forestry Range & Wildlife Management, Islamia University Bahawalpur 63100, Pakistan

<sup>2</sup> Department of Wildlife Management, PMAS-Arid Agriculture University, Rawalpindi 46300, Pakistan

\*Corresponding Author Email: sangamuaar@gmail.com

### ABSTRACT

The present study was conducted in two protected areas of the Salt Range i.e. Chumbi Surla Wildlife Sanctuary (CSWS) and Diljabba Domeli Game Reserve (DDGR) to generate information about preferred habitat of Grey francolin, a medium size game bird, also serving as biological control operator. Four habitat types were selected and compared for the habitat analysis study. Through vegetation survey, forty three plant species were recorded from study area, including; nine trees, six shrubs, sixteen herbs, nine grasses and three agriculture crops. In addition to this, other variables such as altitude, slope, aspect and water availability were also considered for habitat preference by Grey francolin. In CSWS, Grey francolin showed high preference for the habitat having Ivelve's value (IV) of 0.26, while in DDGR, high preference was shown for the habitat having Ivelve's value 0.19. Habitat-II having high elevation and aspect ranges with steep slope and having water with higher IVI for trees, seems to be the most important component for the Grey francolin to select this habitat in the entire four habitats in both CSWS and DDGR. Results would help in conservation of Grey francolin in the Salt Range.

**Key words:** Grey francolin, Preferred Habitat, Salt Range, Protected area.

### INTRODUCTION

Habitat is essential for an animal species as it provides shelter, food and water, the three basic demands of life and hence, each species exists within particular conditions of habitat, depending upon its needs and potential to survive (White and Garrot, 1990). The habitat selection by a species is a hierarchical process and it varies among different animal species (Kotliar and Wiens, 1990), due to which analysis of habitat becomes difficult (McGrath *et al.* 2003). Grey francolin (*Francolinus pondicerianus*), is a medium-sized game bird of Family Phasianidae and is found in open, dry and arid parts of the Asia (IUCN, 2013; Roberts, 1991): Pakistan, south-eastern Iran, India, Bangladesh, and northern Sri Lanka. Its origin allowed it to live easily in cultivated areas where it can find cover, food, and ground for nesting (del Hoyo *et al.* 1994; Fuller *et al.* 2000). The abundance and distribution of grey francolin is largely affected by habitat characteristics such as canopy and, thickness of vegetation, variety of habitat, soil moisture content and, easy access to food (Wijeyamohn *et al.*, 2003). In Hawaii, grey francolin is associated with shrub lands, savannas and coastal kiaw forests in dry, low elevation areas, avoiding brushy understory (Islam, 1999). They are often seen on well-watered, human-altered environments such as golf courses and lawns; the species occurs from sea level to 1000 m elevation (Scott *et al.* 1986; Pratt *et al.* 1987).

Grey francolin is native bird of Pakistan (Ali and Ripley, 1983; Roberts, 1991; Islam, 1999), however, under different environmental conditions shows local movements upto 81 km seasonally within its habitat. In Pakistan, Grey francolin is widely distributed from the west of Indus valley to south of the foothills of Himalayas (Roberts, 1991). It is rarely found above an elevation of 1200 m in Pakistan and usually found feeding on bare soil or low grass cover in open and scrub country (Rasmussen and Anderton, 2005). They may roost at night on low thorny branches of trees or shrubs in pairs or family groups called "coveys" and have camouflaging plumage to live in vegetation that is not so dense (Sharma, 1983; Roberts, 1991).

Grey francolin lives near cultivated fields and as an indicator species for farmland ecosystems, decline in its population have been reported in the past (Chaudhary and Bhatti, 1992; Islam, 1999). Increased use of pesticides due to agriculture expansion and habitat degradation can be cited as main causes behind its decline. A rapid decline in its natural habitat has been reported by Roberts (1991), through its food loss, excessive predation, habitat destruction, intensification of agricultural practices and pressure on scrub forests for use as fodder, timber wood and fire wood needs. It is listed as Least Concern on IUCN Red List, one of the reasons behind this is that it has a vast distribution range (Birdlife International, 2012). Keeping in view the declining trend in population of Grey francolin, the current study was conducted in Salt Range, one of the major areas of its distribution in Pakistan. This study

generated information about preferred habitat and association of Grey francolin in different habitat types in the Salt Range.

## MATERIALS AND METHODS

**Study Area:** The study was conducted at Chumbi Surla Wildlife Sanctuary (CSWS) and Diljabba-Domeli Game Reserve (DDGR) located in the Salt Range, Pakistan between 32°41'- 32°56' N and 71°50' - 74°E having 250 m-1520 m elevation (Awan, 1998) (Fig. 1). Climate of area is dry sub-tropical with cool winters and hot summers. Temperature ranges from 10°C to 41°C and average annual rainfall is 500 mm. It has mixture of sub-tropical semi-evergreen and tropical thorn forest and has wetlands, torrents, farm lands and hills, due to which good diversity of wild animals exist here (Chaudhry *et al.* 1997).

**Methodology:** Through a reconnaissance survey, study sites were selected for data collection, on the basis of occurrence of Grey francolin and accessibility of the area. Study area was divided into different habitat types as potential sites for the grey francolin; four different habitat types of Grey francolin was identified in the study area including; i) cultivated crop fields and associated natural vegetation on boundaries, ii) natural forest and associated grassland, iii) open lands, and iv) wetlands and associated natural vegetation. For habitat preference, vegetative survey of all dominated plant species of selected habitats was conducted by using quadrature method, size of quadrature was 10 m x 10 m for trees, 4 m x 4 m for shrubs and 1 m x 1 m for herbs/grasses (Schemnitz, 1980). Ten quadrates each for trees, shrubs and herbs / grasses were laid down in each selected habitat type.

Cover and frequency of plant species falling inside the quadrates were recorded and later on density, relative density, frequency, relative frequency, dominance, relative dominance and Importance Value Index (IVI) of recorded plant species were calculated as described by Coroi *et al.* (2004) using the following formula:

$$\text{Importance Value Index (IVI)} = \text{RD} + \text{RF} + \text{RC}$$

Physical features of habitats such as elevation, slope, aspect, and terrain and water availability were also noted. To record habitat use frequency by Grey francolin in selected habitat types, 80 quadrates (40 in CSWS and 40 in DDGR) on 40 transects of 0.5-1km in length and 100 m in width (depending upon habitat) were laid down and presence of the bird or its signs such as faecal pellets / droppings, footprints and feathers within a distance of 50-100 m from the transect was noted (Aryal, 2009). The quadrature was considered "occupied habitat" area in case any Grey francolin or its signs were found within the "potential habitat" area. Area within habitat in which

occurrence of Grey francolin or its signs were found maximum was considered preferred.

Habitat preference was analyzed through Ivelv's electivity index (IV), using the following formula;

$$\text{IV} = (\text{U}\% - \text{A}\%) / (\text{U}\% + \text{A}\%)$$

Where "U" represents "used" and "A" represents "availability". Values of this index range from -1.0 to +1.0. If for a habitat aspect (e.g. an elevation), IV > 0, this illustrate a preference by the Grey francolin for that aspect, while IV < 0 indicates avoidance and IV = 0 indifference (Ivelv, 1964; Aryal, 2009).

## RESULTS

**Vegetative structure of selected habitats in Salt Range:** Forty three plants species were recorded from habitats of Grey francolin in study area including nine trees, six shrubs, sixteen herbs, nine grasses and three agricultural crops.

In Habitat-I, dominant tree species was *Acacia modesta* (IVI=20.91) while shrub was *Ziziphus jujuba* (IVI= 8.91), and herb was *Carthamus oxyacantha* (IVI= 39.93). Dominant grass was *Heteropogon contortus* (IVI= 72.26). Density of Grey francolin per hectare found in this habitat was 10.15 individuals (Table 1). In Habitat-II, *Acacia modesta* (IVI= 100.5) was dominant tree species while dominant shrub included *Gymnosporia royleana* (IVI= 42.54), only herb was *Sonchus arvenses* (IVI =4.44) and dominant grass was *Heteropogon contortus* (IVI= 132.26). Density estimate of Grey francolin in this habitat was 15.5 individuals per hectare (Table 2). In Habitat-III, *Acacia modesta* (IVI= 62.82) was major tree. Dominant shrub included; *Ziziphus jujuba* (IVI= 42.96). Herbs was *Heteropogon contortus* (IVI = 152.88), and *Desmostachya bipinnata* (IVI = 60.45) was dominant grass. Density of Grey francolin per hectare found in this habitat was 9.85 individuals (Table 3). In Habitat-IV, the major tree species included *Acacia modesta* (IVI= 30.91). Major shrubs was *Ziziphus jujuba* (IVI = 52.72) and herbs was *Sorghum hellepense* (IVI= 42.38). *Saccharum bengalense* (IVI= 130.18) was among dominant grasses. Density of Grey francolin found in this habitat was 10.65 individuals per hectare (Table 4).

Although these plant species were found in all habitats types in study area (CSWS and DDGR), but they have different IVI value in each habitat; such as *Acacia modesta* has highest IVI value in both study areas among all tree species in three out of four selected habitats; cultivated, natural forest, and open land. Plant species used for roosting by Grey francolin were also identified in the study area, which included *Acacia modesta*, *Acacia nilotica* and *Ziziphus jujuba* in CSWS and *Dalbergia sissoo*, *Acacia modesta* and *Ziziphus jujuba* in DDGR.

**Habitat Preference through Ivelv' Index in Salt Range:** In CSWS, Grey francolin showed high

preference for the habitat having Ivelve's value of 0.26, elevation of 697 m to 704 m, with slope of 25 ° to 55 °, open aspects (without dense vegetation cover) and where water was available. While in DDGR, high preference was shown by Grey francolin for habitat having elevation from 505 m to 523 m with aspect that was not very close and slope of 25 ° to 45 ° with water availability having Ivelve's value 0.19 (Table 5).

Habitat-II was the most preferred habitat of Grey francolin, which is natural forest having highest density per hectare (15.5) with elevation range from 697 m to 704 m having slope of 25 ° to 55 ° both open and

close aspects and where water was available in CSWS, and in DDGR, an elevation of 505 m to 523 m with slope of 25 ° to 45 ° (Fig. 2-3). In addition to have these variables, this habitat type had vegetation like *Acacia modesta*, *Acacia nilotica*, *Dalbergia sissoo*, and *Olea ferruginea*, which provide cover to the Grey francolin for nest building and for roosting during night time. Highest IVI values of these tree species in the habitat with other variables as compared to other habitats caused the preference of this particular habitat by Grey francolin over other habitats in Salt Range (CSWS and DDGR).

**Table 1. Plant species and corresponding density of Grey francolin recorded from cultivated habitat of Salt Range.**

Scientific Name	R.D	R.F	R.C	IVI	D/Hac
<b>Trees</b>					<b>10.15</b>
<i>Acacia modesta</i>	0.357	12.08	7.76	20.91	
<i>Acacia nilotica</i>	0.106	3.71	2.62	6.43	
<i>Ziziphus mauritiana</i>	0.06	1.44	0.96	2.46	
<b>Shrubs</b>					
<i>Ziziphus jujube</i>	0.73	4.34	3.84	8.91	
<i>Gymnosporia royleana</i>	0.333	5.16	2.25	7.74	
<i>Capparis spinosa</i>	0.07	2.27	2	4.34	
<i>Adhatoda zeylanica</i>	0.09	2.27	0.83	3.19	
<b>Herbs</b>					
<i>Carthamus oxyacantha</i>	8.88	13.23	17.82	39.93	
<i>Asphodulus tenuifolices</i>	9.3	9.51	5.13	23.94	
<i>Oxalis corniculata</i>	1.08	10.33	7.59	19	
<i>cynoglossum lanceolatum</i>	0.03	1.44	3.84	5.31	
<i>Astragallus spinosus</i>	0.06	2.89	1.92	4.87	
<i>Chenopodium album</i>	1.173	5.16	10.3	16.63	
<i>Sonchus asper</i>	2.27	9.51	2.46	14.24	
<i>Achyranthus bidentata</i>	0.59	8.25	4.17	13.01	
<i>Sonchus arvensis</i>	0.023	2.27	2	11.43	
<i>Solanum surattense</i>	0.73	7.43	2.58	10.74	
<i>Parthinium hexycantha</i>	0.23	4.54	5	9.77	
<i>Tribulus terrestris</i>	1.063	3.71	3.42	8.19	
<i>Boerhavia procumbens</i>	0.293	5.16	1.12	6.66	
<i>Euphorbia granulata</i>	0.13	1.44	1.92	3.49	
<b>Grasses</b>					
<i>Heteropogon contortus</i>	52.58	8.88	10.9	72.36	
<i>Cynodon dactylon</i>	43.48	13.43	11.35	68.26	
<i>Desmostachya bipinnata</i>	30.75	8.88	21.17	60.8	
<i>Polypogan monspeliensis</i>	25.1	15.5	19.5	60.1	
<i>Saccharum bengalense</i>	7.19	3.71	17.32	28.22	
<i>Poa annua</i>	2.09	1.44	3.84	7.37	
<i>Eulaliopsis binata</i>	0.03	1.44	0.96	2.43	

Key: T= Tree, S=Shrub, H= Herb, G= Grass, C=Crop, RD = Relative Density, RF = Relative Frequency, RC= Relative Cover IVI = Importance Value Index (IVI = RD + RF + RD).

**Table 2. Plant species along with density of Grey francolin recorded from natural forest habitat of Salt Range.**

Scientific Name	R.D	R.F	R.C	IVI	D/Hac
<i>Acacia modesta</i>	3.55	25.66	33.61	62.82	<b>9.85</b>
<i>Olea ferruginea</i>	1.38	11.76	6.55	19.69	
<i>Ziziphus nummularia</i>	0.31	5.88	3.27	9.46	
<i>Ziziphus mortiana</i>	0.39	9.09	1.58	11.06	
<i>Dalbergia sissoo</i>	0.29	6.06	1.12	7.47	
<i>Acacia nilotica</i>	0.27	4.99	1.85	7.11	
<i>Prosopis glandulosa</i>	0.09	3.03	2.25	5.37	
<b>Shrubs</b>					
<i>Ziziphus jujube</i>	2.57	17.13	23.26	42.96	
<i>Adhatoda zeylanica</i>	1.91	15.68	4.91	22.5	
<i>Dodonea viscosa</i>	1.55	11.76	6.55	19.86	
<i>Gymnosporia royleana</i>	0.75	5.88	6.55	13.18	
<i>Capparis spinosa</i>	0.04	1.96	3.27	5.27	
<b>Herbs</b>					
<i>Boerhavia procumbens</i>	1.02	8.02	9.53	18.57	
<i>Euphorbia granulata</i>	0.09	3.03	4.51	7.63	
<b>Grasses</b>					
<i>Heteropogon contortus</i>	91.7	25.66	41.52	158.88	
<i>Desmostachya bipinnata</i>	32.53	12.12	15.8	60.45	
<i>Saccharum bengalense</i>	36.12	9.09	7.9	53.12	
<i>Cenchrus ciliaris</i>	6.28	15.15	12.41	33.84	
<i>Cynodon dactylon</i>	18.99	8.02	13.42	32.43	

**Table 3. Plant species with density of Grey francolin recorded from open land habitat of Salt Range.**

Scientific Name	R.D	R.F	R.C	IVI	D/Hac
<b>Trees</b>					
<i>Acacia modesta</i>	14.08	55.88	30.54	100.5	<b>15.5</b>
<i>Capparis aphylla</i>	2.375	23.52	10.842	36.73	
<i>Acacia nilotica</i>	0.138	2.94	13.052	16.12	
<i>Prosopis glandulosa</i>	0.138	2.94	1.004	4.07	
<i>Dalbergia sissoo</i>	0.138	2.94	0.803	3.87	
<b>Shrubs</b>					
<i>Gymnosporia royleana</i>	1.428	26.46	14.666	42.54	
<i>Ziziphus jujube</i>	2.041	11.76	6.826	20.62	
<i>Capparis spinosa</i>	0.1	2.94	2.81	5.85	
<b>Herb</b>					
<i>Sonchus arvensis</i>	0.1	2.94	1.4	4.44	
<b>Grasses</b>					
<i>Heteropogon contortus</i>	75.95	29.4	26.918	132.26	
<i>Desmostachya bipinnata</i>	45.319	11.76	35.774	92.84	
<i>Saccharum bengalense</i>	19.234	5.88	29.152	54.26	
<i>Cynodon dactylon</i>	15.95	8.82	15.49	40.26	
<i>Polypogon monspeliensis</i>	22.94	11.76	10.65	45.35	

**Table 4. Plant species with density of Grey francolin recorded from wetland habitat of Salt Range.**

Plant Species	R.D	R.F	R.C	IVI	D/Hac
<b>Trees</b>					
<i>Acacia modesta</i>	4.05	24.28	22.58	30.91	<b>10.65</b>
<i>Dalbergia sissoo</i>	12.78	11.9	1.76	26.44	
<i>Butea monosperma</i>	0.56	7.5	8.98	17.04	
<i>Prosopis glandulosa</i>	0.48	9.52	5.28	15.28	

<i>Acacia nilotica</i>	1.23	9.64	2.59	13.46
<i>Olea ferruginea</i>	0.07	2.5	2.24	4.81
<b>Shrubs</b>				
<i>Ziziphus jujube</i>	2.55	31.9	18.27	52.72
<i>Gymnosporia royleana</i>	0.21	5	6.47	11.67
<i>Calotropis procera</i>	0.36	7.14	1.76	9.26
<i>Cappris spinosa</i>	0.07	2.5	4.49	7.06
<i>Adhatoda zeylanica</i>	0.48	2.38	1.05	3.91
<b>Herbs</b>				
<i>Sorghum hellepense</i>	14.12	7.14	21.12	42.38
<i>Sonchus arvensis</i>	0.14	2.5	6.74	9.38
<i>Carthamus oxyacantha</i>	0.24	2.38	3.52	6.14
<i>Sonchus asper</i>	0.14	2.5	2.24	4.88
<b>Grasses</b>				
<i>Saccharum bengalense</i>	83.23	24.52	22.43	130.18
<i>Cynodon dactylon</i>	20.73	12.14	24.82	57.69
<i>Heteropogon contortus</i>	29	12.5	11.23	52.73
<i>Desmostachya bipinnata</i>	25.62	7.38	12.5	45.5
<i>Typha angustata</i>	1.28	4.88	11.04	17.2
<i>Cenchrus ciliaris</i>	1.11	7.26	4	12.37
<i>Polypogan monspeliensis</i>	1.41	2.5	4.49	8.4

Table 5. Habitat preference of Grey Francolin in Salt Range through Ivelv’s electivity index (IV).

Study Sites	Habitat Type	Available Variables				Ivelv’s Value	Used Variables
		Elevation (m)	Slope (°)	*Aspect	Water Availability		
DDGR	I	407-460	15-45	3	1	0	Random Use
	II	505-523	25-45	1-4	1	0.19	Most Preferred
	III	451-460	20-45	2-3	0	-0.08	Avoid
	IV	363-398	15-65	1-4	1	0.13	Less Preferred
CSWS	I	705-717	25-45	4	0	-0.05	Avoid
	II	533-561	20-55	1-4	1	0.15	Less Preferred
	III	652-685	15-45	1-3	1	0	Random Use
	IV	697-704	25-55	3-4	1	0.26	Most Preferred

\*Aspect =1 (Open), 2(Close), 3(Not dense), 4(In-between).

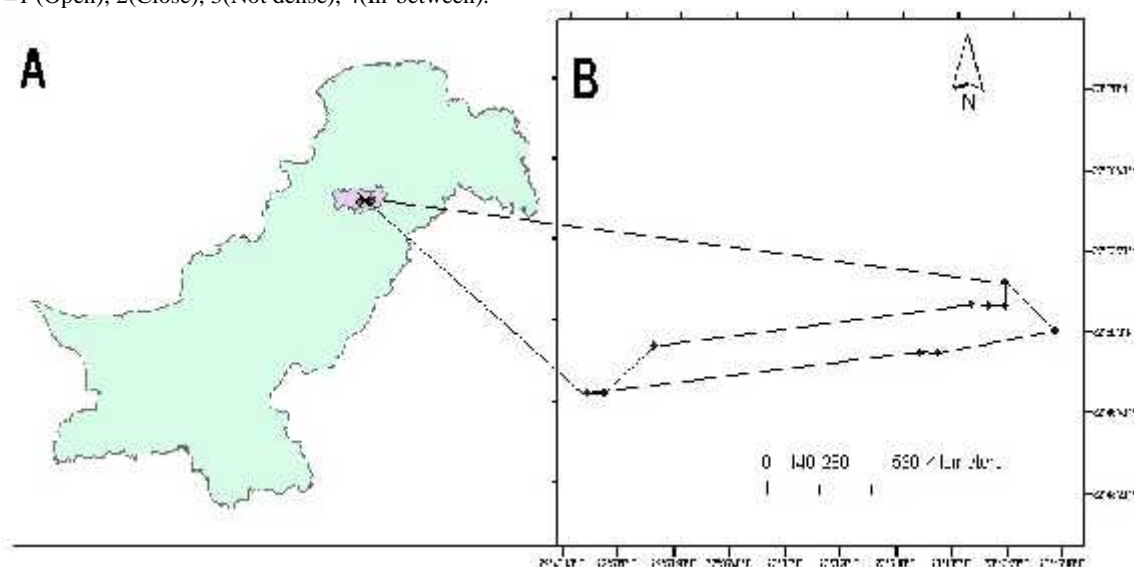


Figure 1. A- Map showing location of Salt Range, B- Arc GIS based map of the sites selected for data collection within Salt Range, Punjab, Pakistan.

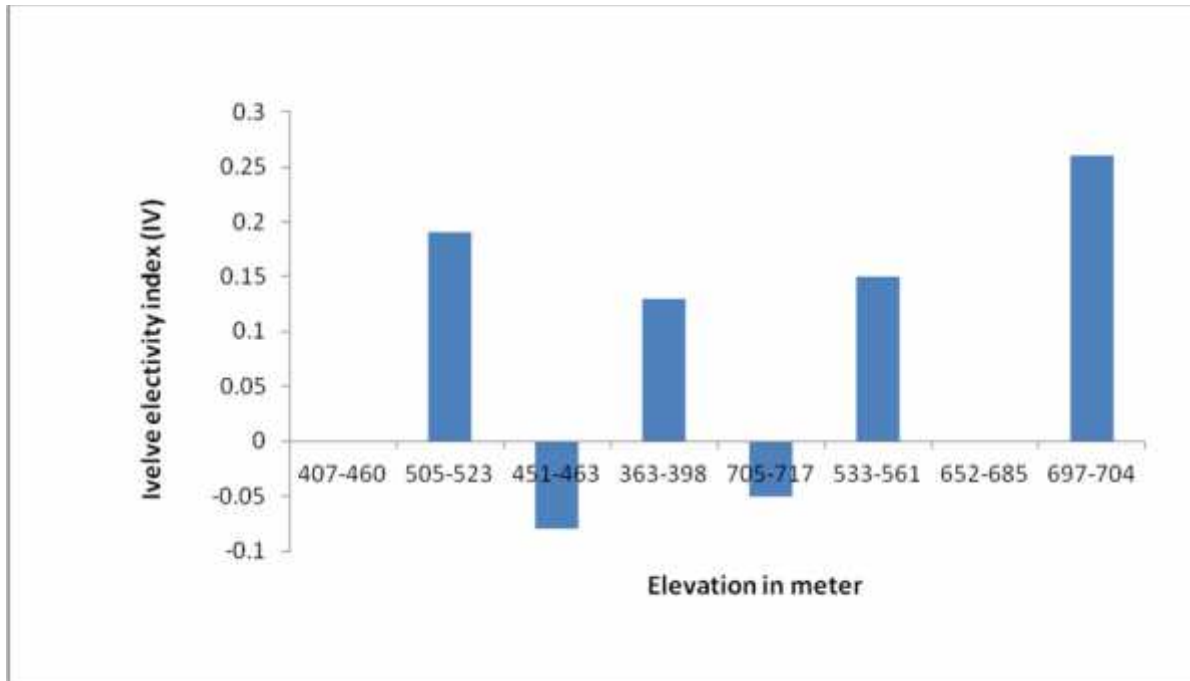


Figure 2. Elevation preference by Grey Francolin in Salt Range.

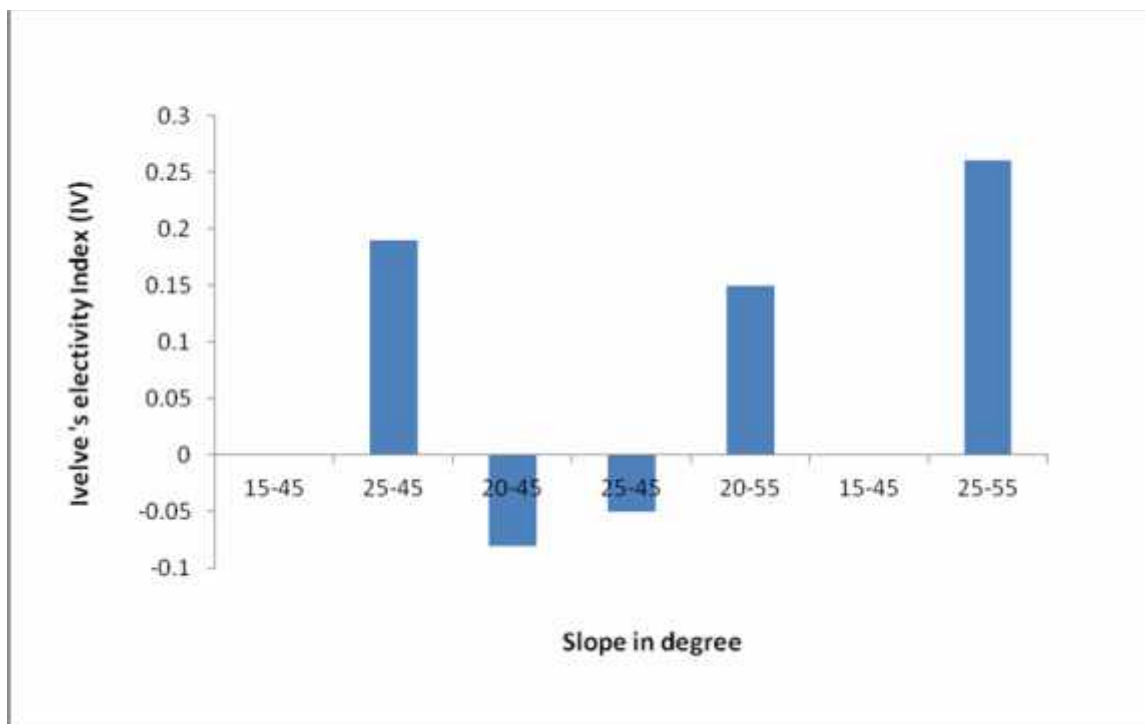


Figure 3. Slope preference by Grey Francolin in Salt Range.

### DISSCUSSION

Current study indicated that vegetation cover in CSWS and DDGR supports Grey francolin population and provides habitat for this species. Presence of *Acacia modesta* and *Acacia nilotica* in three out of four selected

habitats among forty three plant species in Salt Range showed that Grey francolin prefers thorny vegetation in its habitat as compared to non thorny vegetation. These finding are supported by Khan (2010), who revealed that Grey francolin is mostly found in tropical thorn forest as compared to irrigated forest in Lal Suhanra National Park

(LSNP), Pakistan. While presence of *Olea ferruginea* in habitats of Grey francolin in CSWS and *Dalbergia sissoo* in DDGR, shrub of *Ziziphus jujuba* and grasses like *Heteropogon contortus*, *Desmostachya bipinnata* and *Cynodon dactylon*, in both CSWS and DDGR habitats, indicates that these species are also important for Grey francolin in its habitat selection, that may provide better cover for shelter and nesting and roosting sites. In a study by Hussain *et al.* (2012) in agro-ecosystem of Pothwar Plateau, Pakistan, scrub forest habitat was found to be preferred by Grey francolin, where dense cover of *Dalbergia sissoo* and *Desmostachya bipinnata* was available.

Habitat-II found a pure wild area with maximum values of IVI for trees (33.01) in CSWS and in DDGR (19.10) and IVI of shrubs (24.55) and (17.99) with density of 15.5 Grey francolin per hectare, respectively. These findings are supported by Mahmood *et al.* (2010), who compared three different habitats to find out the most preferred habitat of Grey francolin in Lehri Nature Park, Punjab, Pakistan, wild habitat-II (natural forest) having high IVI value for trees (31.18) and high frequency of shrubs having (52.5) was the preferred habitat for species with (0.54±0.2) individuals per hectare.

The results of the present study is also supported by Salek *et al.* (2004) who proposed that high density of wild Grey partridge (*Perdix perdix*) were related with the presence of herbaceous land, unmanaged wilderness and farmlands around habitat in Prague, the Czech Republic. Similarly, Liao *et al.* (2007), found that common Hill Partridge (*Arborophila torqueola*), use areas that had thick tree and shrub cover in Baiposhan Natural Reserve Sichuan, China. In Sri Lanka, Grey francolin mostly occupy habitat with dwarf bushes and thorn scrub vegetation such as *Acacia eburnean* (Wijeyamohn *et al.* 2003). According to Ullah (1991), in Faisalabad Grey francolin lives in arid land. It was reported by Ali (2005) that in Rakh Sardaran Game Reserve, Hari Pur, Pakistan, Grey francolin strongly preferred woodland and wooded ravines and avoided agricultural fields.

Tree species like *Acacia modesta*, *Acacia nilotica*, *Dalbergia sissoo* and shrub like *Ziziphus jujuba* were identified as main roosting tree for the Grey francolin in the study area of CSWS and DDGR. According to Sangha (1987), in India, Grey francolin roosts in groups in low thorny trees. At night it roosts on small trees like *Acacia nilotica* and *Dalbergia sissoo*. Roberts (1991) found that Grey francolin roosts on low trees and shrubs and sometimes on low branches, rarely found on the ground for roosting with sparse vegetation.

No previous literature was found on such record of variables which are present in different habitat types

and Grey francolin shows preference or avoidance for that habitat in particular environment as recorded in this study like elevation, slope, aspect and availability of water source along with vegetation in an area. Only few studies address the importance of some attributes of habitat that are essential in the selection of a habitat by Grey francolin such as Khan (2010) reported that Grey francolin in desert condition of LSNP prefers places with thick shrub cover and soil moisture. Different type of vegetation plays an important role in sustaining of stable population of Grey francolin in Salt Range (CSWS and DDGR). Although among all four selected habitats, there were small differences in frequencies and densities of shrubs, herbs and grasses, the major difference was found in IVI values for trees. Habitat-II having high elevation and aspect ranges with steep slope and water with higher IVI for trees, seems to be the most important component for the Grey francolin to select this habitat in the entire four habitats.

**Acknowledgements:** Authors are grateful to Higher Education Commission of Pakistan for providing financial support for conducting this research study. Thanks are also to Idea Wild US Organization for providing some field equipment for the study.

## REFERENCES

- Ali, S. and S. D. Ripley. (1983). Handbook of the Birds of India and Pakistan. Oxford Univ. Press, Delhi, India.
- Ali, S. S. (2005). Habitat preferences of Black francolin (*Francolinus francolinus*) and Grey francolin (*F. pondericianus*) during the breeding season in Rakh Sardaran Game Reserve, Pakistan. Life, Earth and Health Science.
- Aryal, A. (2009). Habitat ecology of Himalayan Serow (*Capricornis thar.*) in Annapurna Conservation Area of Nepal. Tiger Paper, 36(4): 12-20.
- Awan, G. A. (1998). Ecology of Punjab Urial (*Ovis vaginei Punjabiensis*) in the Salt Range, Punjab. (Unpublished) M. Phil. Thesis. Quaid-i-Azam Univ. Islamabad, Pakistan, 78 pp.
- Azam, M. M., A. Q. Nazar and N. Abbas. (2008). Some observations on the population Status of Punjab Urial (*Ovis vignei punjabiensis*) in district Chakwal. Rec. Zool. Surv. Pakistan, 18: 1-3.
- BirdLife International (2012). *Francolinus pondicerianus*. In: The IUCN Red List of Threatened Species. Version 2014.2. www.iucnredlist.org. Downloaded on 14 September 2014.
- Chaudhry, A. A. and M. N. Bhatti. (1992). Biology of Grey Francolin (*Francolinus Pondicerianus*) in the Central Punjab Plains. In: Proc. 12<sup>th</sup> Pakistan

- Cong. Zool. Zoological Soci. Pakistan, Lahore, p. 161 – 162.
- Chaudhry, A. A., I. I. Agha, A. Hussain, R. Ahmad, and M. Hameed. (1997). Biodiversity in a typical sub-mountainous protected area Chumbi Surla Wildlife Sanctuary, Punjab, Pakistan. In: Mufti, S. A., C. A. Woods and S. A. Hasan (eds.), The Biodiversity of Pakistan. Pakistan Mus. Nat. Hist. Islamabad, p. 63-80.
- Coroi, M., M. S. Skeffingtonb, P. Gillera, C. Smitha, M. Gormallyc and G. O'donovan. (2004). Vegetation diversity and stand structure in streamside forests in the south of Ireland. *Forest Ecology and Management*, 202: 39–57.
- Del Hoyo, J., A. Elliot, and J. Sargatal. (1994). Handbook of the birds of the world. In: Lynx (ed.), New world Vultures to Guinea fowl. Barcelona, p. 412-567.
- Fuller, A. R., P. J. Carroll and McGowan. (2000). Partridges, Quails, Francolins, Snowcocks, Guineafowl and Turkeys. Status survey and conservation action plan 2000-2004. WPA/BirdLife/ SSC Partridges, Quails and Francolin Specialist Group. IUCN. The World Conservation Union, Gland, Switzerland, 63pp.
- Hussain, I., A. Nisa, and S. Khalil. (2012). Population biology of Grey Francolin (*Francolinus pondicerianus*) in agro-ecosystem of the pothwar plateau, Pakistan. *J. Chin. Birds*, 3(2): 91-102.
- Islam, K. (1999). Erckel's Francolin (*Francolinus erckelii*), Black Francolin (*Francolinus francolinus*), Grey Francolin (*Francolinus pondicerianus*). *Birds of North America*, 23 pp.
- IUCN. (2013). Red List of Threatened Species. Downloaded September, 18, 2014 at <http://www.iucnredlist.org>.
- Ivelv, V. S. (1964). *Experimental Ecology of the feeding of Fishes*. Yale University Press, New Haven.
- Khan, S., B. S. Javed and J. N. Shah. (2009). Distribution and status of Galliformes in the United Arab Emirates. *Internat. J. Galliformes Conser.*, 1: 58 – 62.
- Khan, W. A. (2010). Studies on the comparative ecology of the South Persian Black partridge, (*Francolinus francolinus henrici*), and the Northern Grey partridge, (*Francolinus pondicerianus interpositus*), in Lal Suhanra National Park, Bahawalpur, Punjab, Pakistan. (Unpublished) Ph.D. Thesis. PMAS-Arid Agri. Univ. Rawalpindi, Pakistan.
- Kotliar, N. B. and J. A. Wiens. (1990). Multiple scales of patchiness and patch structure, a hierarchical framework for the study of heterogeneity. *Oikos*, 59: 253 – 260.
- Liao, W. B., J. C. Hu and C. Li. (2007). Habitat utilization during the pairing season by the Common Hill Partridge (*Arborophila torqueola*) in Baiposhan Natural Reserve, Sichuan, China. *Ornith. Science*, 6(2): 87–94.
- Mahmood, K., T. Ahmad, A. Khan, A. Mahmood, and W. Mahmood. (1997). Some Notes on Avifauna of Mangla Reservoir. *AJ&K, Pakistan J. Ornith.*, 1:1-2.
- McGrath, M. T., S. DeStefano, R. A. Rigs, L. L. Irwin, and G. J. Roloff. (2003). Spatially explicit influences on northern goshawk nesting habitat in the interior Pacific Northwest. *Wildlife Monographs*. 154: 1 – 63.
- Pratt, H. D., P. L. Bruner, and D. G. Berrett. (1987). *A Field Guide to the Birds of Hawaii and the Tropical Pacific*. Princeton Univ. Press, Princeton. 528p.
- N. J. Rasmussen, P. C. and J. C. Anderton. (2005). *Birds of South Asia: the Ripley Guide*. Smithsonian Institution and Lynx Editions, 121 pp.
- Roberts, T. J. (1991). *The birds of Pakistan. Non-Passeriformes. Vol. I*. Oxford University Press, Karachi, p. 232-233.
- Sangha, H. S. (1987). Roosting habits of grey partridge. *Newsletter for Birdwatchers*. 27 (7–8): 15.
- Schemnitz, D. S. (1980). *Wildlife Management Technique Manual*. Wildlife Society, USA, Washington D. C. 686 pp.
- Scott, J. M., S. Mountainspring, F. L. Ramsey, and C. B. Kepler. (1986). *Forest Birds Communities of Hawaiian Islands: their dynamics, ecology, and conservation*. *Stud. Avian Biol.* no. 9. Cooper Ornithol. Soc., Camarillo, CA.
- Subramanian, C., M. C. Sathyanarayana and K. Kamarajan. (2002). Habitat utilization by grey jungle fowl (*Gallus sonneratii*) in theni Forest Division, Meghamalai, Tamilnadu. *Proceedings of the National Symposium on Galliformes*. A. V. C. College, p. 28–36.
- Ullah, H. (1991). Studies on the biology, habitat, distribution pattern and food of Grey Partridge (*Francolinus pondicerianus*) in Tehsil Faisalabad, (Unpublished), MSc. Thesis. Univ. of Agri, Faisalabad: 182 pp.
- Weijemohan, S., R. Vandercone and Santiapillai. (2003). Observation on the Grey Partridge (*Francolinus pondicerianus*) in the vicinity of Giant's Tank, Sri Lanka. *PQF News*, 19:11-143.
- White, G. C. and R. A. Garrott. (1990). Habitat analysis. In: *Analysis of wildlife radio tracking data*. Academic press, London. p. 183–204.