RESEARCH PAPER

Distribution and habitat analysis of Himalayan Monal pheasant (*Lophophorus Impejanus)* in Palas valley, district Kohistan, Pakistan

Hamid-ur-Rahman[1,2], Maqsood Anwar[1], Nadeem Munawar[1,3*], Tariq Mahmood[1], Ali Akhter[1], M. Ahmed Subhani[3]

[1]*Department of Wildlife Management, PMAS-Arid Agriculture University Rawalpindi, 46300, Pakistan*

[2]*Institute of Agriculture Sciences and Forestry, University of Swat, KPK, Pakistan*

[3]*Ministry of Climate Change-TBTTP, Islamabad, Pakistan*

Abstract

The present study was conducted to assess the distribution and habitat association of Himalayan Monal (*Lophophorus impejanus)* in Palas valley, district Kohistan. For this purpose, three different habitats were selected i.e. Karosair mixed conifer forest, Deewan Nallah Fir-spruce & Betula habitat and Kabkot Fir-spruce Habitat. Each habitat was further divided into 3-4 study points for systematic surveys. We conducted a call count method to record the population of Monal pheasants and established 10 call count stations and 30 quadrats in the study area (3 in each site). A total of 21 calls were noted during this study having an overall population density of 7.5 birds/km². The highest population density recorded in Karosair mixed conifer forest was 8.92 birds/km², followed by 7.14 birds/km² in Deewan Nallah Fir-spruce & Betula, while the lowest (5.95 birds/km²) was recorded in Kabkot Fir-spruce habitat. The results showed that the population density of Monal was not significantly different in all three habitat types (F = 2.31; df = 26; P = 0.1208). Distribution was also examined by direct and indirect signs comprising sighting, ground scratching, faecal droppings, feathers footprints and information gathered from hunters, native communities and wildlife officials. Major flora recorded from Monal habitat was *Pinus wallichian*, *Betula utilis*, *Abies pindrow, Picea smithiana, Cedrus deodara, Debregeasia salicifolia, Geranium wallichianum,* and *Berberis brandisiana* etc. The study concluded that the population of pheasants is decreasing through hunting, habitat degradation, increasing human settlement, plant extraction for medicinal, collection of non-timber forest products, fires and livestock grazing.

* Corresponding Author: Dr. Nadeem Munawar PhD ✉ nadeemmunawer@gmail.com

Introduction

Himalayan Monal Pheasant (*Lophophorus impejanus*) belongs to Order Galliformes and Family Pheasanidae is widely distributed throughout the foothills of the Himalayan mountain systems and other northern parts of the country in Kaghan, Swat, Swat Kohistan, Dir Kohistan, and Indus Kohistan, Azad Jammu & Kashmir and to a limited extent in Chitral (Malik and Shah, 1980; Roberts, 1991). It is considered the most significant biogeographical zones as well recognized for its ecological, cultural, and esthetic values (Kaul and Shakya, 2001; Seth, 2019). Among 52 species of pheasants in the world, seven are found in Pakistan and it is listed as Least Concern in IUCN Red Data Book (IUCN, 2019). Himalayan Monal is reported in all Himalayan protected areas and is native to Afghanistan, Pakistan, India, Nepal, Bhutan, China and Myanmar (Yin, 1970; Johnsgard, 1986; Bhuju, 2001; Bhuju *et al.*, 2007; Zaman 2008; Xiaochun *et al.*, 2011; Miller, 2013).

It is found in a variety of altitudinal range that varies with habitat, location and seasons. It occupies the upper temperate oak-conifer forests and sub-alpine oak forests interspersed with open grassy slopes, cliffs and alpine meadows between 2400 - 4500 m elevations, mostly concentrating in a narrow belt between 2700 - 3700 m (Grimmet *et al.,* 1998). The Monal prefers steep southward slopes and huge rocks for roosting which protects from predators such as martens and foxes. They exhibit clear migration in elevation, reaching as low as 2000 m in winter. During the summer in the breeding period, it prefers the high altitudinal forest and ventures above the tree line to wander on the grassy slopes (Ramesh, 2003). During the winter, it is found in coniferous and mixed forests with a high proportion of rhododendrons and bamboo, where it shelters from the weather. Its food may vary according to a locality but it usually includes seeds, tubers, shoots, berries, terrestrial insects and their larvae (Ramesh *et al.,* 1999). In winter the ground which is snow-free the Monal spends most of their days extracting tubers, roots and insects with the help of their beak through which it digs the earth surface. During other seasons of the year, it mostly feeds on roots, leaves, young shoots, acorns, seeds, and berries. They usually feed in groups of three and four, they can dig quite deep in snow up to 25 cm deep and do not descend in winter below the snow-line, being very hardy birds (PCDP, 2002).

These birds are known to be extremely sensitive to human exploitation (Fuller and Garson, 2000; Nawaz *et al.,* 2008). Their ecological characteristics capture the complexities of the ecosystem and yet are simple enough for easy monitoring. Changes in land use and other anthropogenic pressures affect pheasant habitats (Ramesh, 2003; Bhattacharya *et al.,* 2007). The sensitivity of this bird species to human disturbance may be the reason for their dwindling population. Hunting for colored plumage and meat, habitat degradation, and habitat loss are major threats to this species (Selvan *et al.,* 2013). During winter when the ground is covered with snow, Himalayan Monal is forced to descend to lower elevations near human habitation, where density-dependent and intra-specific competition increases predation and threats of poaching. On the other hand during the winter season, human presence in lower altitudes makes it restricted to a higher range, which causes a higher mortality rate during winter. In Pakistan and Azad Jammu & Kashmir hunting pressure is particularly high for Galliformes for food, skins, or recreation as well as hunt by local and non-local professional hunters (Kandel *et al.,* 2018; Awan *et al.,* 2012) but habitat degradation, poaching and developmental activities in most of their ranges are also among major threats to this species. Thus several of these factors have collectively contributed to the decline of wild populations of pheasants in their native regions (Kandel *et al.,* 2018). Diseases in the wild or captivity are also a source of declining of pheasants populations (Zaman, 2008).

Keeping in view the existing level of Monal pheasant habitat loss with respect to size and quality, its population is declining in Pakistan and data is required for its conservation. The present study has been conducted to assess population status and to explore characteristics of habitat being preferred by

this bird. This study is expected to identify the limiting and facilitating factors for better conservation of this bird species in Pakistan.

Materials and methods

Study area

The study was conducted in Palas valley which lies in district Kohistan of Khyber Pakhtunkhwa Province, Pakistan. It covers an area of about 1,352 km², the geographic extent is from 72° 57′ E to 35° 12′ N and elevation ranges from 665 m to 5236 m. At lower elevations, Musha'gah River bisects the valley into northern facing slopes dominated by temperate coniferous forest and southern facing slopes dominated by broad-leaved oak forest. Much of the valley is remote with rugged terrain. The climate varies from sub-tropical at low elevations to alpine at high elevations with mixed temperate forests in between. These microclimatic differences give rise to distinct forest and vegetation types. The subtropical zone is mostly covered by scrub forest mainly comprising *Acacia modesta* and *Olea ferruginea* (Ashraf *et al.,* 2004). Palas valley experiences a typically temperate climate, with estimated annual precipitation of 900-1350 mm, falling predominantly as snow during the winter months (Rafiq, 1994). It receives some summer rains, lying along with the approximate northern limit of the influence of the summer monsoon, but is somewhat sheltered from this monsoon by the mountains to the south.

The dominant evergreen plant species are Himalayan Cedar (*Cedrus deodara),* Himalayan Blue Pine (*Pinus wallichiana),* West Himalayan Silver Fir (*Abies pindrow),* Himalayan Spruce (*Picea smithiana),* and two oaks species *Quercus baloot* and *Quercus semecarpifolia* (Rafiq, 1994). Important wildlife species of Palas valley include Musk deer (*Moschus muschiferus),* Markhor (*Capera falconer),* Grey goral (*Naemarhedus goral),* Black bear (*Selenarctus thibetanus),* Rhesus Macaque (*Macaca mulatta),* Common leopard (*Panthera pardus),* Western tragopan (*Tragopan melanocephalus),* Himalayan monal (*Lophophorus impejanus),* Koklas pheasant (*Pucrasia macrolopha),* Kalij pheasant (*Lophura*

leucomelanos), Himalayan snowcock (*Tetraogallus himalayensis*) and Eurasian Blackbird (*Turdus merula),* etc (Qamar *et al.,* 2011).

Study design

Reconnaissance survey

The study was conducted from September 2016 to July 2017. In order to get a fair knowledge of the study area, an exploration survey was carried out in November 2016. During the survey, all the primary and secondary information regarding major habitat types, direct and indirect evidence related to the presence or absence of Himalayan Monal pheasant were collected from wildlife staff, villagers, shepherds and hunters. Two call counts were conducted at dawn on each morning of sampling, with one observer measuring from each station.

Population estimation

The population density of Monal Pheasant was estimated using the call count method. Call count stations having a circular area of a 300 m radius, were placed approximately 400 m apart to avoid sampling overlap (Miller, 2010). Ten study points were selected in three habitat types in Palas Valley within the potential habitat of Himalayan Monal (Table 1). The survey parties were well conversed with the physical situation of the valley and sub-valleys and have the experience of time required having access to different points. The survey points were selected and shown to the surveyors. Single points were manned usually by two recorders facing opposite directions to ensure that all calling birds are recorded. In the call count method, a survey sheet was used to record the point name, date of survey, aspect, altitude, longitude, latitude, major trees and shrubs. Survey time was 45 minutes after the first bird call. The count was not done in adverse climate (only in case of heavy rainfall, thick fog, or strong winds). The methodology followed the techniques used by Ramesh (2005). The following formula was used for population density:

$$D = \frac{n}{l}$$

N= no. of calls of birds

L= total area

Habitat analysis

The quadrate method was used for assessing phytosociology of Himalayan Monal in the study area (Muller-Dombois and Ellenberg, 1974). A quadrate delimits an area in which vegetation cover can be estimated, plants counted or species listed. Three quadrates were taken at each site. The size of the quadrate was 10 x 10 m for trees, 4 x 4 m for shrubs and 1 x 1 m for herbs. In this way, maximum quadrates were taken in all ten habitat sites.

A measuring tape was used the establishing the layout of quadrates. The total numbers of quadrates were 30 in the study area. In each study point, 3 quadrates were selected. Through this method plant density, frequency, dominance, relative density, relative frequency, relative dominance and importance value index of each plant species were calculated. Following habitat, parameters were assessed to determine the habitat use by the species.

Tree layer

The tree layer was quantified by taking the quadrate of 10 x 10 m for all tree species and the number of tree species estimated along with the density, diversity and species richness surveyed the sampling area by the technique used by Hacker *et al.* (1990).

Shrub layer

The shrub layer was quantified in 4 × 4 m quadrate. Species and their number were recorded for estimation of density, diversity and species richness in the study area.

Ground vegetation

Herbs and grasses were sampled in 1 x 1 m quadrate by following the method of Hacker *et al.* (1990). Habitat parameter was computed by applying the following formulas:

$$\text{Density (D)} = \frac{\text{Total number of individual of a species}}{\text{Total numbers of quadrates surveyed} \times \text{Area of one quadrate}}$$

$$\text{Relative Density (RD)} = \frac{\text{Total number of individuals of a species}}{\text{Total number of individuals of all species}}$$

$$\text{Frequency (F)} = \frac{\text{Number of Quadrates in which a species occurs} \times 100}{\text{Total number of quadrates samples}}$$

$$\text{Relative Frequency (RF)} = \frac{\text{Frequency value of a species} \times 100}{\text{Total frequency value of all species}}$$

$$\text{Cover} = \frac{\text{Area covered by species}}{\text{Total area of the sampling unit}} \times 100$$

$$\text{Relative cover} = \frac{\text{Cover of the species}}{\text{Total cover of all species}} \times 100$$

Important value index (IVI) of each species was calculated as follows:

Important Value Index (IVI) = Relative Density + Relative Frequency + Relative Cover.

Statistical analysis

Data recorded on different variables or study parameters within each habitat and between the habitats were analyzed using appropriate statistical method i.e. Kruskal-Wallis test for medians of the three habitats and ANOVA for Analysis of Variance. All statistical calculations were performed using computer software namely "The Statistix v. 8.1" (Analytical Software, 2005).

Results

The population density of Monal Pheasant in the study area was estimated at 7.5 ± 3.2 birds/km². In Karosair mixed coniferous forest, the population density was 8.92 ± 2.3 birds/km². In Deewan Nallah Fir-spruce & Betula habitat population density was 7.14 ± 2.06 birds/km². In Kabkot Fir-spruce habitat, the population density of Monal was 5.95 ± 3.14 birds/km² (Table 2). Data analysis revealed that the population densities of Monal were not significantly different among the three habitat types (F = 2.31, df = 26, p = 0.1208). The analysis of population density in three habitat types i.e. Karosair mixed conifer forest habitat, Deewan Nallah Fir-spruce and Betula habitat and Kabkot Fir-spruce habitat. Analysis of Variance (ANOVA) was used for the equality of variances. For the results of the f-test, the value was not significantly different. Kruskal-Wallis test was applied for medians of Karosair mixed conifer forest habitat, Deewan Nallah Fir-spruce, Betula habitat and Kabkot Fir-spruce habitat which showed that habitat was not significantly different from each other (H= 3.444; df = 2 and p = 0.1788).

Table 1. Details of three habitat types and ten study points were selected for data collection.

Habitat Types	Study Point	Elevation	Coordinates		Area (km²)
			N	E	
Karosair Mixed conifer forest Habitat	Point 1	3336m	35°0417.55	73°0948.89	0.28
	Point 2	3270m	35°04.070	073°10.206	0.28
	Point 3	3193m	35°0355.66	73°1016.73	0.28
	Point 4	3145m	35°0414.84	73°0835.37	0.28
Deewan Nallah Fir-spruce and Betula Habitat	Point 1	3012m	35°0049.97	73°1449.81	0.28
	Point 2	3198m	35°0006.86	73°1451.86	0.28
	Point 3	3113m	35°0024.88	73°1547.90	0.28
Kabkot Fir-spruce Habitat	Point 1	3406m	34°5910.36	73°1253.66	0.28
	Point 2	3158m	34°5953.31	73°1307.01	0.28
	Point 3	3068m	34°5906.11	73°1156.00	0.28

Vegetation analysis of the study area

For habitat analysis number of plant species recorded from the habitat of *Lophophorus impejanus* were 54, including 7 trees, 10 shrubs, 37 herbs and grasses (Fig. 1). Dominant plant species were *Picea smithiana* (IVI= 14.88) which was followed by *Abies pindrow* (IVI= 13.86*), Betula utilis* (IVI = 11.60), *Pinus Wallichian* (IVI= 10.89), *Quercus incana* (IVI= 7.45), *Quercus baloot (*IVI = 5.29) and *Cedrus deodara* (IVI= 4.18). The dominant shrubs species were *Vibernum nervosum* (IVI= 22.08*), Dephne oleoides* (IVI= 19.37), *Desmodeum elegans* (IVI= 17.39*),

Debregeasia salicifolia (IVI= 16.17), *Bebris lyceum* (IVI= 15.06), *Skimmia laureola* (IVI= 13.25*),* and *Vibernum grandiflorum* (IVI= 11.63). Dominant herbs and grasses were *Colachicum luteum* (IVI= 10.56), *Corydalis govaniana* (IVI= 9.58), *Rumex dentatus* (IVI= 9.32*), Primula denticulatae* (IVI= 9.31*), Oxalis corniculata* (IVI= 8.67), *Dryopteris juxtaposita* (IVI=8.20*), Rumex obtisufolius* (IVI= 8.19*), Primula rosea* (IVI= 8.10*), Verbascum Thapsus* (IVI= 7.67), *Chrysopogon gryllus* (IVI= 7.38*), Fragaria vesca* (IVI= 5.40) and *Euphorbia wallichii* (IVI= 4.05) (Fig. 2).

Table 2. Population density of Monal Pheasant in the study area.

Habitat Types	Point named	Area (Km²)	No. of calls	Population density/km²	Mean density/ habitat ± S.E
Karosair Mixed conifer forest Habitat	Point 1	0.28	3	10.71	8.92 ± 2.30
	Point 2	0.28	1	3.57	
	Point 3	0.28	4	14.28	
	Point 4	0.28	2	7.14	
Deewan Nallah Fir-spruce and Betula Habitat	Point 1	0.28	1	3.57	7.14 ± 2.06
	Point 2	0.28	2	7.14	
	Point 3	0.28	3	10.71	
Kabkot Fir-spruce Habitat	Point 1	0.28	2	7.14	5.95 ± 3.14
	Point 2	0.28	0	0	
	Point 3	0.28	3	10.71	
Total		10 2.8	21	74.97	7.5 ± 3.2

Vegetation analysis of Karosair mixed conifer forest habitat

A total of 43 plant species were recorded in the Karosair mixed conifer forest habitat including 5 trees, 8 shrubs, and 30 herbs, grasses. Major tree

species were recorded were having the highest Importance Value Index (IVI) were *Pinus wallichian* (31.80) followed by *Abies pindrow* (27.98*), Quercus incana* (27.27). Shrubs species that dominate in the area were *Vibernum nervosum* (IVI= 29.54*),*

Desmodeum elegans (IVI= 25.50), *Daphne oleoides* (IVI= 25.30), *Debregeasia salicifolia* (IVI= 22.40) and *Beberis lycium* (IVI= 13.34). The three top scoring IVIs herbs/grass were *Colchicum luteum* (IVI= 14.67), *Primula denticulata* (IVI= 13.41) and *Primula rosea*. A member of this having the lowest IVI (4.81) was *Cynodon dactylon* (Fig. 3). A study was conducted on distribution and habitat use of pheasant in the headwater forests of Khola, Annapurna conservation area, Nepal by Poudyal (2008) who divided the area into six different habitats. During the winter season, the bird was found on higher elevations, was observed in two out of six habitats where the percentage of tree canopy was 17.0 (± 11.2 SD) and shrub coverage was 12 (± 0.00 SD).

Vegetation analysis of Deewan Nallah Fir-spruce and Betula habitat
Fifty plant species were recorded from this habitat including 7 trees, 10 shrubs and 32 herbs/grasses. The highest Importance Value Index (IVI) estimated for trees was *Abies pindrow* (39.91). The IVIs estimated for the three dominant shrubs were 23.49

for *Daphne oleoides,* 23.41 for *Vibernum nervosum* and 18.25 for *Vibernum grandiflorum. Parrotiopsis jacquemontiana* was the least occurring with IVI value of 13.11 only. Three herbs/grasses having the highest IVI were *Corydalis govaniana* (IVI= 13.98), followed *Primula denticulatae* (IVI= 13.80) and *Primula rosea* (IVI= 11.44), while the lowest IVI (7.04) was recorded for *Cynodon dactylon* (Table 2; Fig. 4).

Vegetation Analysis in Kabkot Fir-spruce habitat
Fifty-three plant species were recorded in Kabkot Fir-spruce Habitat of Monal pheasant which is composed of 6 trees, 10 shrubs and 37 herbs/grasses (Fig. 3). Dominated trees with IVI were comprised of *Betula utilis* (65.62), followed by *Picea smithiana* (27.28), *Abies pindrow* (24.02), *Pinus wallichian* (15.08) and *Cedrus deodara* (11.08). The dominated shrubs scoring the IVI were *Skimmia laureola* (30.71), *Aconogonum molle* (20.45), *Bebris lyceum* (16.58), *Vibernum nervosum* (15.05) and *Debregeasia salicifolia* (13.82). The herbs and grasses included the highest value *Dryopteris juxtaposita* (14.48).
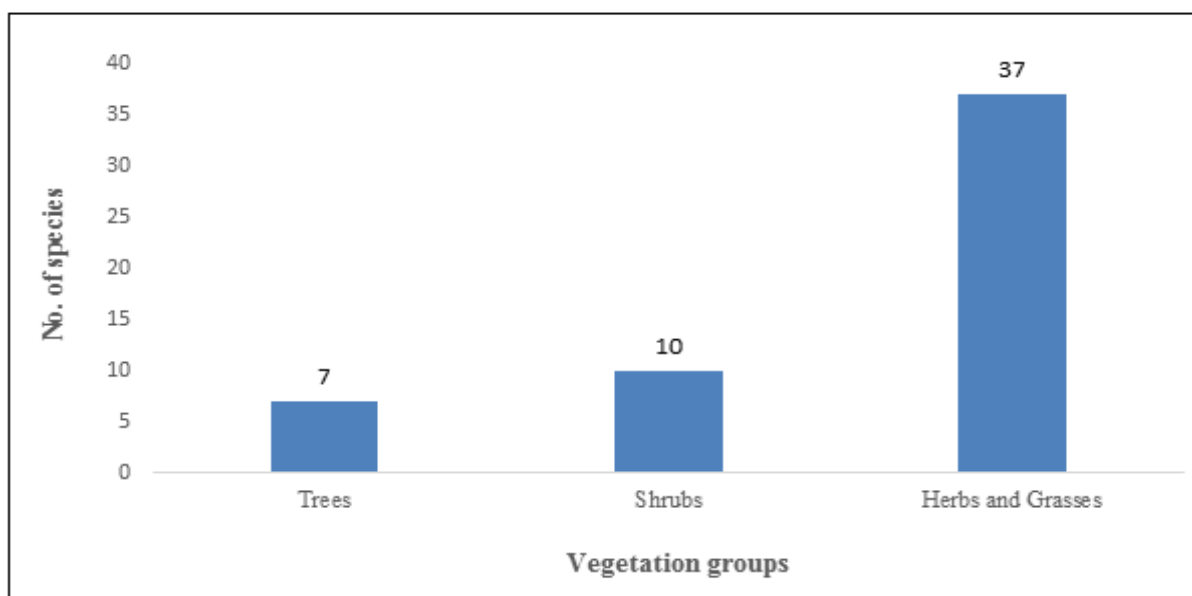

Fig. 1. Composition of flora in the habitat of Monal Pheasant in Palas valley.

Discussion
The present study was conducted to determine the population status and habitat association of Monal Pheasant in Palas valley. In the study area, six birds were observed in a group sitting together, the

maximum number of birds (n = 4) was seen at point 3 with a population density of 14.28 birds/km² in Karosair Mixed conifer forest habitat. Miller (2010) studied Western Tragopan, Koklass pheasant and Himalayan Monal population in the Great Himalayan

National Park, Himachal Pradesh, India and reported that the encounter rate was 6.1 birds/km² of Himalayan Monal. This bird was most often sighted alone or in pairs. The average group size was 1.8 ± 2.1 individuals, but most of the time the group was observed as seven members. Ramesh (2003) observed a group with no more than four individuals during the breeding season, whereas Miller observed as many as seven individuals sitting together. The males were not territorial because most of the groups were composed of two to three males, which supported the results of our present study.

The results showed that during spring, in their breeding season they are found in pairs between 3000-3500 m (April-May) and summer 3500-4000 m. The abundance of Himalayan Monal is highest during spring (44.43 ± 5.25 birds/km²) and lowest in summer (17.89 ± 5.86 birds/km²). A comparatively low-density estimate of Himalayan Monal along the least disturbed transect and absence from a highly disturbed transect of the study area (mean elevation 3500 m) in summer (June-September) is indicative of high altitudinal migration. Human presence in lower altitudes makes it restricted to a higher altitude during the winter, which may result in a higher mortality rate during this season (Osmaston, 1927). Himalayan Monal occupies upper temperate oak-conifer forests, subalpine oak forests interspersed with open grassy slopes, cliffs and alpine meadows between 2400-4500 m, mostly concentrating in a narrow belt of 2700-3700 m (Grimmet *et al.,* 1998). They exhibit clear altitudinal migration reaching as low as 2000 m in winter (Ramesh, 2003).
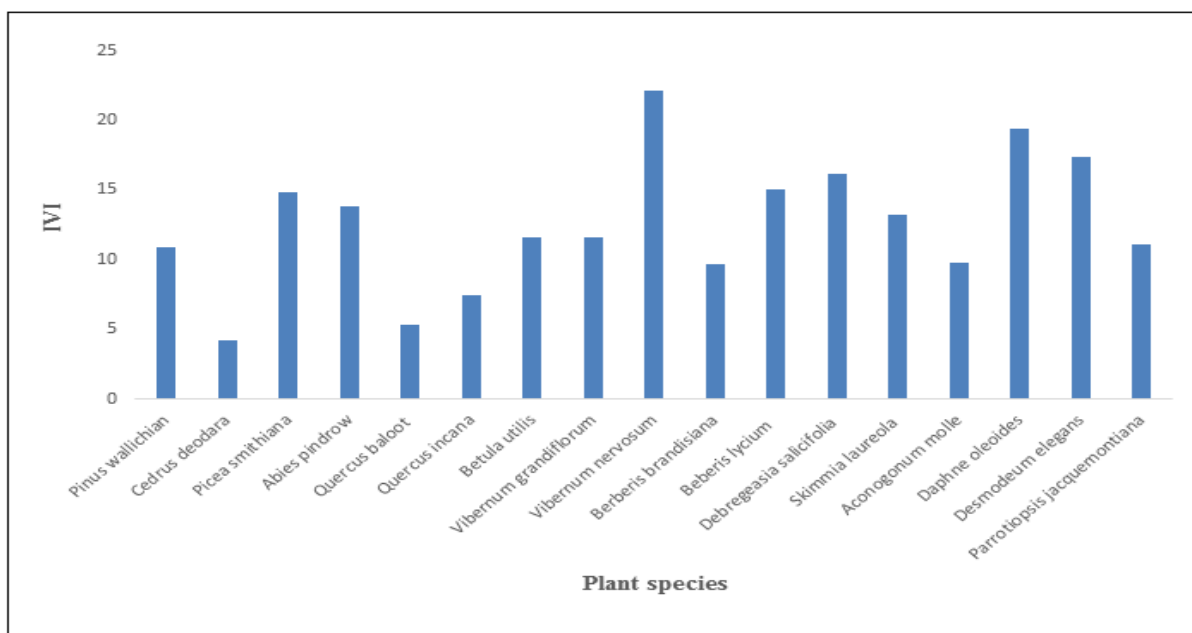

Fig. 2. Trees and shrubs were recorded from Monal's habitat in Palas Valley.

Himalayan Monal distribution, habitat and population status were studied in Tibet, China during 2011 by Xiaochun *et al.* (2011) which showed that birds mainly occur in rocky forests where the dominant tree species include *Quercus semecareifolia, Picea spinulosa* and *Abies spectabilis.* The shrubs layer is comprised of *Salix oritrepha* and *Rosa tibetica* interspersed with steep slopes, cliffs and alpine meadows at an elevation of 3800-4000 m. However, they show tolerance to snow and have been observed to dig through the snow for roots, tubers, other plant parts and invertebrates (McGowan, 1994; Kumar, 1997).

A study conducted in Sagarmatha National Park, Nepal revealed that Himalayan Monal preferred cultivated areas while forest and shrublands are significantly underutilized (Soldatini *et al.,* 2010). The bird was absent from herbaceous vegetation and barren land habitats and the dominant species in its

habitat was *Betula utilis, Abies spectabilis, Rhododendron, Juniper spp, Berberis, etc.*

The species preferred alpine and sub-alpine areas in steep grassy and open rocky slopes and the adjacent forest during summer and descends to lower altitudes in rhododendron forest during winter, especially in times of heavy snowfall (Lelliott, 1981).

Our survey results also showed that Himalayan Monal is threatened in most of their range due to poaching and other anthropogenic factors like hunting pressure, increasing human population and associated degradation, clearance and conversion of habitat into agricultural land. Male Himalayan Monal

had been heavily hunted for their crown feathers in the district of Kohistan. The Monal pheasant begins their altitudinal migration, during summer they move towards the higher elevation and in winter towards lower elevation. These migrations are food-dependent and protection from the harsh weather condition. Bhattacharya *et al.,* (2007) studied in Nanda Devi Biosphere Reserve and concluded that Himalayan Monal used 13 variable habitats including edge habitat, subalpine habitat, northwestern and western aspect, shrub cover and litter depth showed positive influence in the occurrence of pheasants whereas grass cover, livestock presence and herb height showed negative influences.
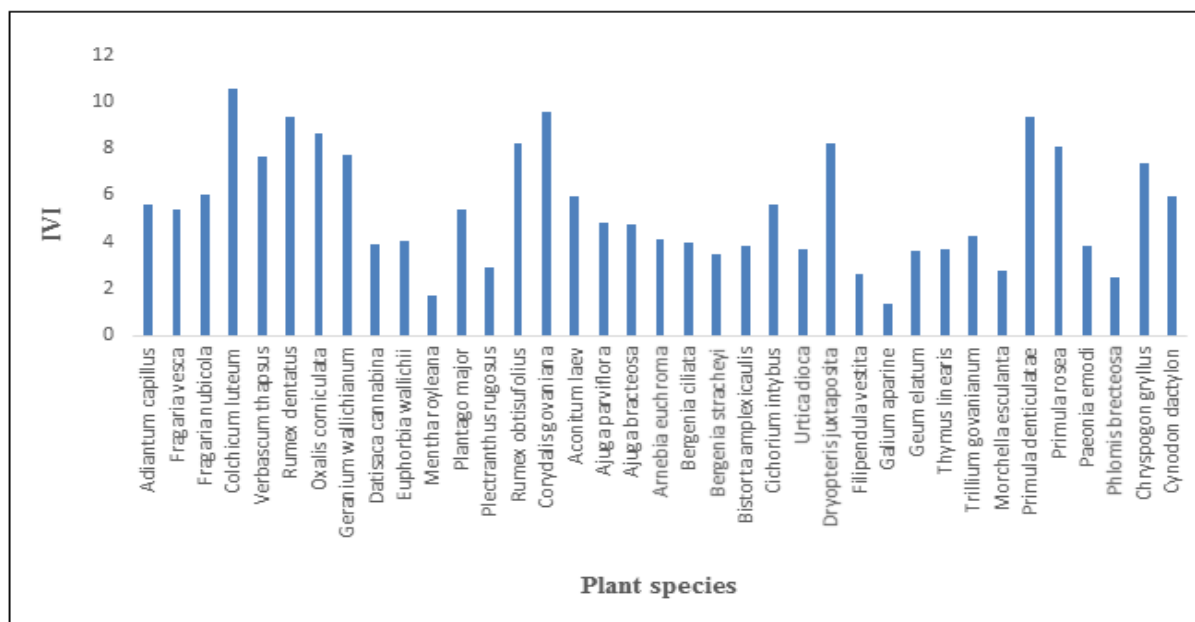

Fig. 3. Herbs and grasses were recorded from the Monal habitat in Palas valley.

From the whole survey and results it is concluded that Himalayan Monal was distributed in all Palas valleys and population density was reported as 7.5 ± 3.2 birds/km². In Karosair mixed conifer forest habitat it was highest (8.92 ± 2.30 birds/km²), followed by Dewaan Nallah Fir-spruce and Betula Habitat (7.14 ± 2.06 birds/km²) and Kabkot Fir-spruce habitat (5.95 ± 3.14 birds/km²). In Pakistan, the population status and detailed habitat analysis of Himalayan Monal are still poorly understood. The present study was conducted in a limited area of district Kohistan. There is a need for further detailed study in the remaining areas of its habitat, so the actual status of this

precious bird can be documented for its better management. Human activities and livestock grazing observed in the area might be the major threat to the Himalayan Monal in the study area. Nationally, increasing demands on natural resources across like plant collection for fodder and medicinal purpose reduced population density in the study area of Kabkot Fir-spruce habitat. The recommendations are suggested to control the pheasant population and conserve its natural habitat by strictly controlling hunting, deforestation, livestock grazing and habitat degradation. It is also recommended that dogs should not be allowed to enter the habitats of pheasants in

the breeding season. The KPK Wildlife Department should initiate public education and awareness campaigns about the importance of wildlife and conservation with public support and continuous monitoring of habitat and population of Monal pheasant is required to understand the importance of pheasants in the ecosystem.

Declaration of interests
All authors declare that there is no conflict of interest.

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