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A Perspective on Avifaunal Diversity and Composition in the Grasslands of Majathal Wildlife Sanctuary, Subtropical Montane Ecosystem of North-western Himalaya, Himachal Pradesh, India

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ABSTRACT
The present research work deals with the avifaunal diversity and community structure in the grasslands of Majathal Wildlife Sanctuary located in the Solan and Shimla districts of Himachal Pradesh. The present work has revealed the presence of 34 species of grassland birds belonging to 29 genera spread under 19 families and 5 orders. Of these, 14 species were obligate grassland species that depend on the montane grassland ecosystem entirely and 20 species were found to be facultatively dependent. The 16 species were reliant for nesting in the habitat and 18 species partly use the habitat for nesting. The Pearson correlation indicated a strong positive correlation between grass and bird species. An analysis of the impact of various anthropogenic activities has also been presented in the present manuscript. This study is the first attempt to describe grassland-dependent birds from the sanctuary.

Key words: Himalayan Sub-tropical Montane grassland, Avifaunal communities, Obligative and Facultative, Ground dwelling birds, Majathal Wildlife Sanctuary (MWLS).

INTRODUCTION

Grass-dominated ecosystems are widespread and cover a significant portion of the Earth's land surface, accounting for approximately one-quarter of the total area (Liu et al. 2021), and play a critical role as wildlife habitat (Wang et al. 2018). Over the past two decades, there has been a growing interest in grassland birds in many regions of the world (Bucher and Nores 1988, McNicholl 1988, Knopf 1994, Peterjohn and Sauer 1999), resulting in numerous studies being conducted (Glover 1969, Goriup 1992, Leslie 1996, Jacobski et al. 2017). Grasslands are recognized as being the most vulnerable habitat in the Indian subcontinent from a biodiversity perspective (Collar 1996, Grimmett et al. 1998, Peet et al. 1999, Baral 2001, Thomas and Palmer 2007, Akash et al. 2018, Joshi et al. 2018) but, due to fragmentation, and modification of grassland ecosystems serious stress is noticed on the dependent faunal diversity (Rosenberg et al. 2019, Lele et al. 2020). The grassland birds are experiencing major population declines (Marques et al. 2020) because present-day management practice is mainly focused on large mammals (Baral 2007). A significant amount of information has already been collected on bird species in India (Narayan and Rosalind 1990, Iqbal et al. 1994) and grassland bird communities (Majumdar and Bramhachari 1986, Rahmani 1992). In Himachal Pradesh, grasslands cover about 16.5% of the total area, occupying 15.3, 21.6, 18.0 and 15.3% of geo-climatic zones 1) (Low hill subtropical), 2) (Mid-hill subhumid), 3) (Mid-hill temperate wet) and 4) (High hill temperate), respectively (Singh et al. 2009). The Himalayan Sub-tropical montane grasslands, thriving at 1000-1800 m elevation, dominated by *Chrysopogon*, *Heteropogon*, *Cymbopogon*, *Imperata*, *Capillipedium* and several other species of grasses, legumes, and herbs from other families (Chandran 2015). Grassland birds rely on specific grassland habitats for various stages of their life cycle, including feeding, nesting, roosting, and wintering (Vickery and Herkert 1999). The Obligate grassland specialists adapted to grassland habitats and make little or no use of other habitat types such as Red Junglefowl (*Gallus gallus*), Indian Peafowl (*Pavo cristatus*), White-crested Kaleej Pheasant (*Lophura leucomelanos*), Himalayan Prinia (*Prinia crinigera*), Crested Bunting (*Emberiza lathami*) and Fire fronted serin (*Serinus pussilus*). Facultative grassland specialists utilize grasslands alongside other habitats but are not entirely dependent on them (Jahan et al. 2022). Destruction of suitable grassland habitats

would partially impact the populations of these birds. Almost negligible information is available pertaining to the diversity, composition, and distribution of grassland birds in the Majathal wildlife sanctuary. This is the first attempt to describe grassland birds from the sanctuary.

MATERIAL AND METHODS

Study area

Majathal Wildlife Sanctuary falls within the mid-Himalayan ranges and present within geo-coordinates of latitude 31°15′00" N - 31°18"45" N and longitude 76°56′45" E - 77°02′18" E comprising an area of about 30.86 km^2 (WIIENVIS 2023) is situated in the Solan and Shimla districts of Himachal Pradesh, India (Fig. 1) (Negi 2002). The sanctuary comprises four beats namely, Harsang bhajji, Chandi, Kangri, and Matrech. The elevation gradient of the study site varies between 575 to 1975m. The soil is hard and clayey loam and rocks are formed of shale, slate and sandstone. The climate of MWLS is sub-tropical, experiencing cold winters with temperatures ranging from 1°C in winter to a maximum of 40°C in summer. The rainfall follows a monsoon pattern, concentrated from July to September, with average monthly rainfall ranging from 17 mm in April to 214 mm in July (Shah et al. 2015, Rahmani et al. 2016). The slopes are sparsely forested with Chir Pine (*Pinus roxburghii*), Ban Oak (*Quercus leucotrichophora*), and Deodar (*Cedar deodar*) are mostly dominated by grassy tracts. The *Chrysopogon*, *Heteropogon*, *Cymbopogon*, and *Imperata* are dominant grasses found in the sanctuary (Fig. 2). This sanctuary provides shelter to globally important fauna such as Cheer pheasant, Leopard, Black bear, and barking deer.

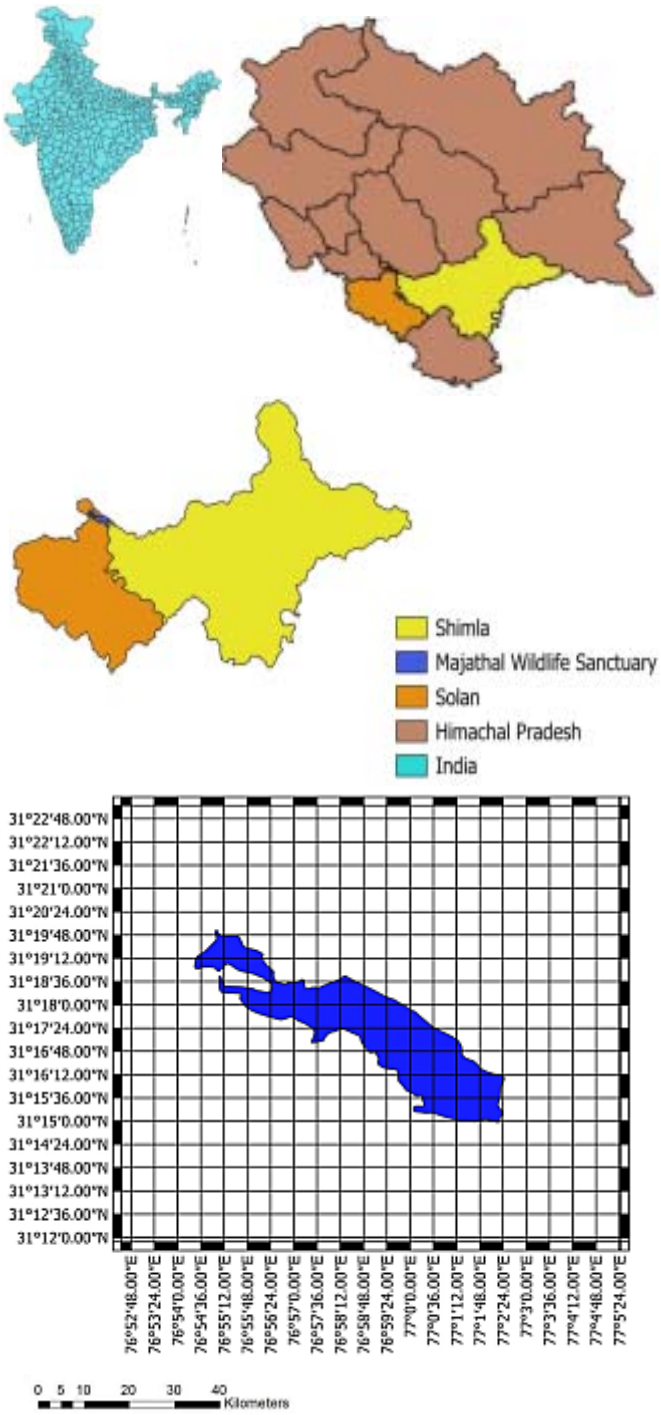
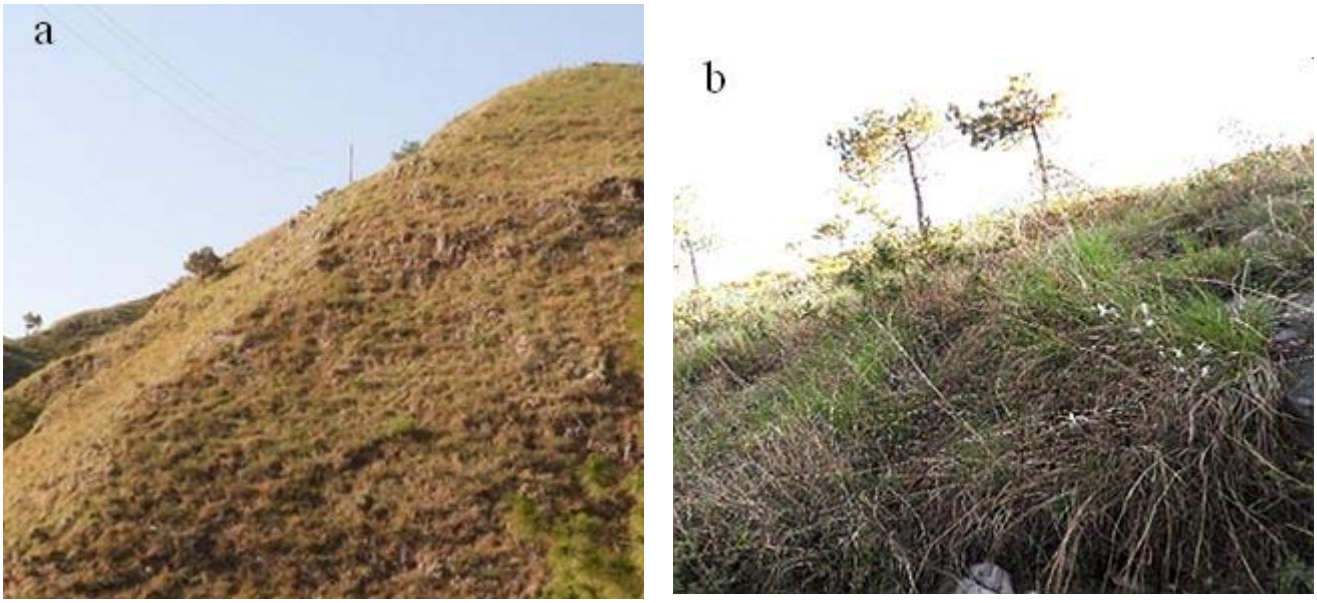


Figure 1. Map of the study area (Majathal Wildlife Sanctuary)

Methods

The present study was conducted in 2023 to study associations of birds with their grassland habitat by using Random sampling and line transect method (Gaston 1980, Sutherland 1996, Bibby et al. 2000). Linear transects were laid out in the four beats of the sanctuary and the length of the transects varied from 3 to 6 km depending upon the area of the beat. A data sheet was maintained for each visit in which all observations were recorded. Nikon Coolpix P1000 camera was used to capture the birds and Nikon Aculon A211 (8×42) binoculars were also used in the field. Identification of birds was done after Ali et al. (1983), Grimmett et al. (1998) and Kazmierczak (2000). The nomenclature was followed as per Manakadan and Pittie (2001). The relationship



(March) (May)

Figure 2. Pictorial view of Montane grasslands of Majathal Wildlife Sanctuary

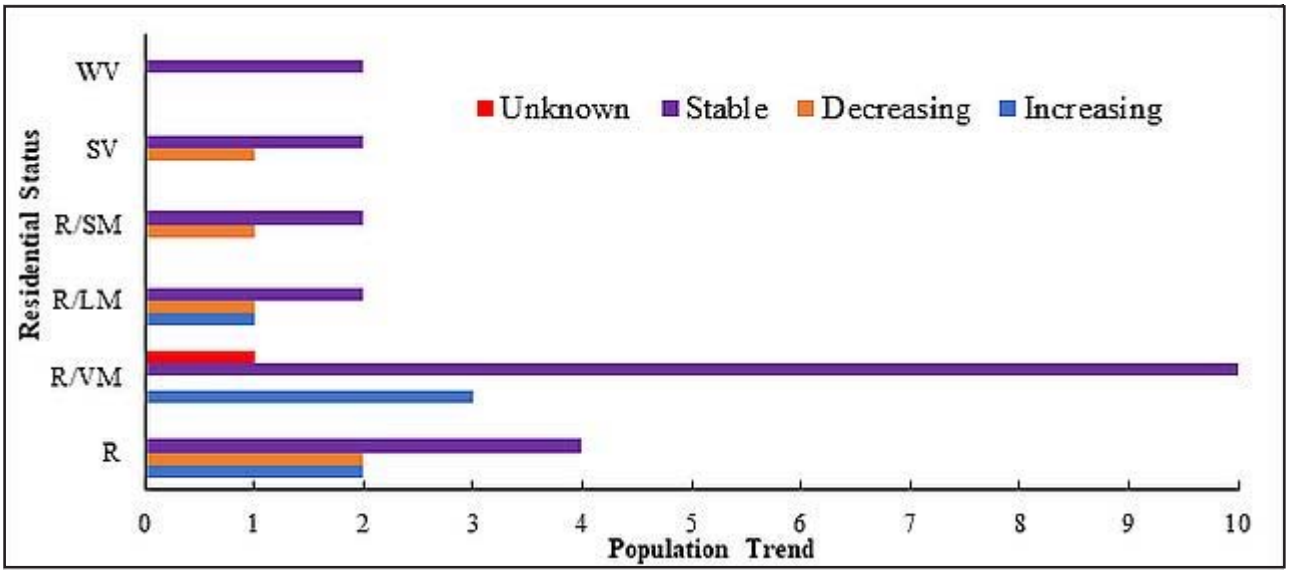


Figure 3. Relationship between population trend and residential status of observed species in the habitat

between residential status and population trend was carried out in the habitat. The residential status was categorized according to their presence in specific season such as Winter Visitor (WV), Summer Visitor (SV), Resident showing Seasonal Movement (R/SM), Resident showing Local Movement, Resident showing Vertical Movement and Resident (R) (Fig. 3).

RESULTS

The exploration of the sub-tropical montane grassland ecosystem of MWLS revealed the presence of a diverse population of birds consisting of 34 species, belonging to 29 genera, spread over 19 families and 5 orders. Of these, 8 species were resident, 14 species were resident with vertical

movement, 4 species were resident with local movement, 3 species were resident with seasonal movement, 3 species were summer visitor, and 2 species were winter visitor (Fig. 3). According to IUCN Red List, the global population trend of 6 species was noticed to be increasing (↑), 5 were decreasing (↓), 22 were stable and the trend of 1 species was unknown (Fig. 3). The Indian Peafowl and White-crested Kaleej Pheasant were documented under Schedule-I (Part III) and Jungle Crow was recorded under Schedule V and the remaining 31 birds were under Schedule IV of the Wildlife Protection Act (IWPA 1972). A systematic list along with their status, dependence, food, and nesting in the habitat based on direct observation and Ali and Ripley (1983 a,b) is presented in Table 1.

Out of the recorded bird species, 14 species were found to be obligative grassland species and 20 species were facultatively dependent in the habitat (Fig. 4). The former included pheasants, buntings, finches, accentor, stonechat, prinia, and pipit and the latter included species such as robins, chats, bulbuls, and thrushes. Muscicapidae was the most dominant and species-rich family with 6 species and the second most abundant family was Phasianidae, comprising 4 species that belong to the order Galliformes. These 4 species of Phasianidae family were totally dependent on the grassland habitat as this family consists mainly ground-dwelling birds. The 16 species of birds prefer to nest in the grassland habitat whereas 18 species were observed to be partly dependent on grasslands, as they use grass to construct their nests. The large-billed crow was observed using the grassland habitat as a roosting ground during dusk.

The 14 grass genera and 7 herb genera were abundantly noticed in the sanctuary. The *Cymbopogon*, *Cynodon*, *Imperata*, *Heteropogon*, and *Sacharum* genera were observed to be dominant and important genera among various grass genera. It was observed that *Serinus pusillus* primarily consumed seeds of *Artemisia* as their main food source. Some common obligate inhabitant species of montane grasslands such as Red junglefowl (*Gallus gallus*), Common Stonechat (*Saxicola torquata*), White-crested Kaleej Pheasant (*Lophura leucomelanos*), Indian Peafowl (*Pavo cristatus*), Black francolin (*Francolinus francolinus*) and Red-headed Tit (*Aegithalos concinnus*) were observed feeding on the seeds and insects. The insects found in montane grasslands such as grasshoppers, beetles, ants, grubs, and caterpillar larvae of many insects and bugs constitute an essential diet for the obligative and facultative inhabitants. The 26 species of birds namely Himalayan Prinia, Altai Accentor, Common Stonechat, Indian Robin, and Pied Bushchat were partly dependent on insects found in the grasslands (Table 1).

The relationship between grasses and birds were further evaluated with the Pearson correlation method and their number were counted monthly from February to June (Fig. 5). This method has yielded an r-value of 0.798842 which indicated that a strong positive correlation exists between grasses and birds.

DISCUSSION

The grass-like *Cynodon dactylon* (Doob grass) was observed to be the main nesting habitat for several ground-nesting passerine birds such as the Oriental skylark, Indian Paddy Pipit, and Black-Winged Stilt (Ali and Ripley 1969, Nair and Pandav 2015). Similar observations were also recorded in the MWLS. The 16 species of birds preferred to nest in the grassland habitat whereas 18 species were observed to be partly dependent on grasslands, as they use grasses to build their nest.

Many bird species, such as sage sparrows and horned larks, rely heavily on the Artemisia plant (Baker et al. 1976, Weins and Rotenberry 1981, Reinkensmeyer 2007). In MWLS among granivorous birds Crested bunting, Eurasian collared dove, and White-capped bunting were found to be dependent on the seeds of *Amaranthus* sp., *Cymbopogon* sp., *Polypogon* sp. *Artemisia* plants usually produce seeds during February and March, hence a good number of Fire-fronted Serin was observed. Furthermore, the common Rosefinch was observed consuming seeds from the *Polygonum* sp. plant in the sanctuary.

Grasshoppers serve as an important source of prey for insectivorous birds in grassland habitats (McEwen 1987, Wiens and Rotenberry 1979, Manakadan 2014). The healthy population of grasshoppers and other insects in the grasslands of Majathal Wildlife Sanctuary accounts for the presence of fair diversity of insectivorous birds.

Table 1. A complete list of avifaunal species diversity and their dependence on the montane grassland habitat

Sr No	Taxon	Conservation status		Residential	Population	Dependence	Food	Nesting
		IUCN	IWPA (1972)	Status	Trend	on grassland	(Preference)	(In the habitat)
Order – Columbiformes Family – Columbidae								
1	Spotted Dove *Spilopelia chinensis* (Scopoli GA 1786)	LC	Sch IV	R/VM	↑	F	Grains of paddy, jowar, pulses, grass and seeds.	+
2	Eurasian Collared Dove *Streptopelia decaocto* (Frivaldszky I 1838)	LC	Sch IV	R/VM	↑	F	Grain and seeds – Wheat, barley, grass and weeds.	+
Order – Cuculiformes Family – Cuculidae								
3	Asian Koel *Eudynamys scolopaceus* (Linnaeus C 1758)	LC	Sch IV	R/LM	→	F	Fruit, berries, and insects	Brood parasite
Order – Galliformes Family – Phasianidae								
4	Black Francolin *Francolinus francolinus* (Linnaeus C 1766)	LC	Sch IV	R	→	O	Grass and weed seeds, grains, tubers, insects	++
5	Indian Peafowl *Pavo cristatus* Linnaeus C 1758	LC	Sch I (Part III)	R	→	O	Grass seeds, grains, shoots, groundnuts, insects	++
6	Whitecrested Kaleej Pheasant *Lophura Leucomelanos* (Gray JE 1829)	LC	Sch I (Part III)	R	↓	O	Grain, seeds, shoots, insects, reptiles and ripe fruits	++
7	Red Junglefowl *Gallus gallus* (Linnaeus C 1758)	LC	Sch IV	R	↓	O	Grains, shoots of grass and crops, fruits and insects	++
Order – Passeriformes Family – Aegithalidae								
8	Red-headed tit *Aegithalos concinnus* (Gould J 1855)	LC	Sch IV	R/SM	→	O	Insects, tiny seeds and berries (Rubus)	++

Sr No	Taxon	Conservation status		Residential Status	Population Trend	Dependence on grassland	Food (Preference)	Nesting (In the habitat)
		IUCN	IWPA (1972)					
	Family – Corvidae							
9	Jungle Crow *Corvus macrorhynchos* 1827 Wagler JG	LC	Sch V	R/VM	→	F (Show roosting in the habitat)	Both animal and vegetable matter	+
	Family – Cisticolidae							
10	Himalayan Prinia *Prinia crinigera* Hodgson BH 1836	LC	Sch IV	R/VM	→	O (Affects low bushes on grassy slopes)	Insects	++
	Family – Emberizidae							
11	Crested Bunting *Emberiza lathami* Gray JE 1831		Sch IV	R/VM	→	O	Chiefly grass seeds	++
12	White-capped Bunting *Emberiza stewarti* (Blyth E 1854)	LC	Sch IV	SV	→	O (Affects grassy hillsides)	Grass seeds	++
	Family – Fringillidae							
13	Fire-fronted Serin *Serinus Pusillus* (Pallas 1811)	LC	Sch IV	R/VM	↑	O (Feed on ground)	Seeds of thistles, Artemesia, Plectranthus and other weeds & grass.	++
14	Common Rosefinch *Caprodacus erythrinus* (Pallas PS 1770)	LC	Sch IV	SV	↓	O	Seeds of weeds, bamboo, millet. wheat, Polygonum	++
	Family – Leiothrichidae							
15	Streaked Laughingthrush *Garrulax lineatus* (Vigors 1831)	LC	Sch IV	R/VM	→	F	Insects, berries and seeds	+

Sr No	Taxon	Conservation status		Residential Status	Population Trend	Dependence on grassland	Food (Preference)	Nesting (In the habitat)
		IUCN	IWPA (1972)					
16	Jungle Babbler							
	Argya striata (Dumont CHF 1823)	LC	Sch IV	R	→	F	Insects, Seeds, grains	+
	Family – Motacillidae							
17	Upland Pipit							
	Anthus sylvanus (Hodgson BH 1845)	LC	Sch IV	R/VM	→	O (Affects steep grassy slopes)	Insects, grass and weed seeds	++
	Family – Muscicapidae							
18	Blue Whistling-thrush							
	Myophonus caeruleus (Scopoli GA 1786)	LC	Sch IV	R/VM	?	F	Earthworm, snail, insects	+
19	Common Stonechat							
	Saxicola torquata (Pallas PS 1773)	LC	Sch IV	WV	→	O (Affects meadows, hillsides and pastures)	Ants, beetles, locusts and insects	++
20	Indian Robin							
	Saxicoloides fulicata (Linnaeus C 1766)	LC	Sch IV	R	→	F	Insects and termites	+
21	Oriental Magpie-Robin							
	Copsychus saularis (Linnaeus C 1758)	LC	Sch IV	SV	→	F	Insects, snails, earthworm and vegetable matter	+
22	Grey Bush Chat							
	Saxicola ferreus Gray JE, Gray GR 1847	LC	Sch IV	R/SM	→	F	Insects and some seeds	++
23	Pied Bushchat							
	Saxicola caprata (Linnaeus C 1766)	LC	Sch IV	R/VM	→	F	Ants, beetles & some vegetable matter and other insects	++
	Family – Nectariniidae							
24	Purple Sunbird							
	Cinnyris asiaticus (Latham J 1790)	LC	Sch IV	R/LM	→	F	Nectar	+

Sr No	Taxon	Conservation status IUCN	Conservation status IWPA (1972)	Residential Status	Population Trend	Dependence on grassland	Food (Preference)	Nesting (In the habitat)
	Family – Paridae							
25	Himalayan Black Lored Tit *Parus xanthogenys* (Vigors NA 1831)	LC	Sch IV	R/VM	→	F	Insects and vegetable matter and berries	+
	Family – Prunellidae							
26	Altai Accentor *Prunella himalayana* (Blyth E 1843)	LC	Sch IV	WV	→	O (Affects hillsides)	Insects and small seeds	++
27	Rufous-breasted Accentor *Prunella strophiata* (Blyth E 1842)	LC	Sch IV	R/VM	→	O (Keeps to ground)	Insects and small seeds	++
	Family – Pycnonotidae							
28	Himalayan Bulbul *Pycnonotus leucogenys* (Gray JE 1835)	LC	Sch IV	R/LM	↑	F	Berries, Nectar, seeds and insects.	+
29	Black Bulbul *Hypsipetes leucocephalus* (Gmelin JF 1789)	LC	Sch IV	R/VM	→	F	Fruit, berries, insects and	+
30	Red-vented Bulbul *Pycnonotus cafer* (Linnaeus C 1766)	LC	Sch IV	R	↑	F	Fruit, berries and nectar	+
	Family – Rhipiduridae							
31	White-throated Fantail *Rhipidura albicollis* (Vieillot 1818)	LC	Sch IV	R/VM	→	F	Insects	+
	Family – Sturnidae							
32	Common Myna *Acridotheres tristis* (Linnaeus C 1766)	LC	Sch IV	R	↑	F	Grains, fruits, insects and grubs.	+
	Family – Zosteropidae							
33	Oriental White-eye *Zosterops palpebrosus* (Temminck CJ 1824)	LC	Sch IV	R/SM	↓	F	Insects, larvae, berries, seeds and nectar	+

Sr No	Taxon	Conservation status		Residential Status	Population Trend	Dependence on grassland	Food (Preference)	Nesting (In the habitat)
		IUCN	IWPA (1972)					
Order – Psittaciformes Family – Psittaculidae								
34	Plum-headed Parakeet *Psittacula cyanocephala* (Linnaeus C 1766)	LC	Sch IV	R/LM	↓	F	Grain, fruits and buds	"

Residential status: R; Resident, R/VM: Resident with vertical movement, R/LM: Resident with local movement, R/SM: Resident with seasonal movements, SV: Summer visitor, WV: Winter visitor, **IUCN:** International Union for Conservation of Nature and Natural Resources, **WPA:** Wild-life Protection Act, **Population trend**: (↑) - Increasing, (↓) - Decreasing, (→) - Stable, (?) – Unknown, **Conservation status**: LC – Least Concern, **Dependence on the habitat**: (O) – Obligate, (F) – Facultative, **Nesting**: (++) - Use habitat for nesting material and occasionally use for nesting (+) - Use habitat for nesting

Habitat loss and degradation are accounting for the decline in the population of grassland-dependent birds in many countries (Goriup et al. 1991, Sauer et al. 2008, Vickery et al. 1999, Johnson and Igl 2001, Manakdan 2014). In the Himachal Pradesh region of NWH, there are negligible scientific studies on ecology and various other aspects of grassland and meadows-dependent birds. These habitats provide breeding and feeding grounds to many important bird species such as Red Junglefowl (*Gallus gallus*), Common Stonechat (*Saxicola torquata*), White-crested Kaleej Pheasant (*Lophura leucomelanos*), Indian Peafowl (*Pavo cristatus*), Black francolin (*Francolinus francolinus*) and Red-headed Tit (*Aegithalos concinnus*) in the sanctuary.

It was observed that the grasslands in Majathal Wildlife Sanctuary are under stress due to many anthropogenic activities such as fire, livestock and household purposes. The Himalayan sub-tropical montane grasslands are highly vulnerable to fires during the summer season (March to May), which is the breeding period of many ground-dwelling birds. Therefore, fires can have negative effects on these birds including the destruction of nests and chick mortality. The timing and frequency of fire can greatly impact the survival of bird species that require specific habitats. Nomadic pastoralism, a traditional form of human livestock-grassland interaction, is still predominant in the mountainous reaches of the Himalayas (Roy and Singh 2013). The Gaddi, a pastoral community, inhabit the MWLS and rely on it for their livestock, particularly sheep and goats. The increase in livestock population is accounting for excessive stress on the grasslands, furthermore, cutting of trees, burning of grass, and conversion of grasslands into agricultural fields (Douglas 2023) coupled with other activities like introduction/ presence of exotic species of grass/plants are accounting for dwindling area of grasslands in the many parts of HP including MWLS.

Studies in other regions of the world have demonstrated that carefully managed areas can have a positive impact on declining species (Swengel 1996, Jacobski et al. 2017). Since the grass was found to be essential for the sustenance of 34 important species of birds in the sanctuary, therefore it is important to devise suitable management practices to protect the existence of grasslands in the sanctuary.

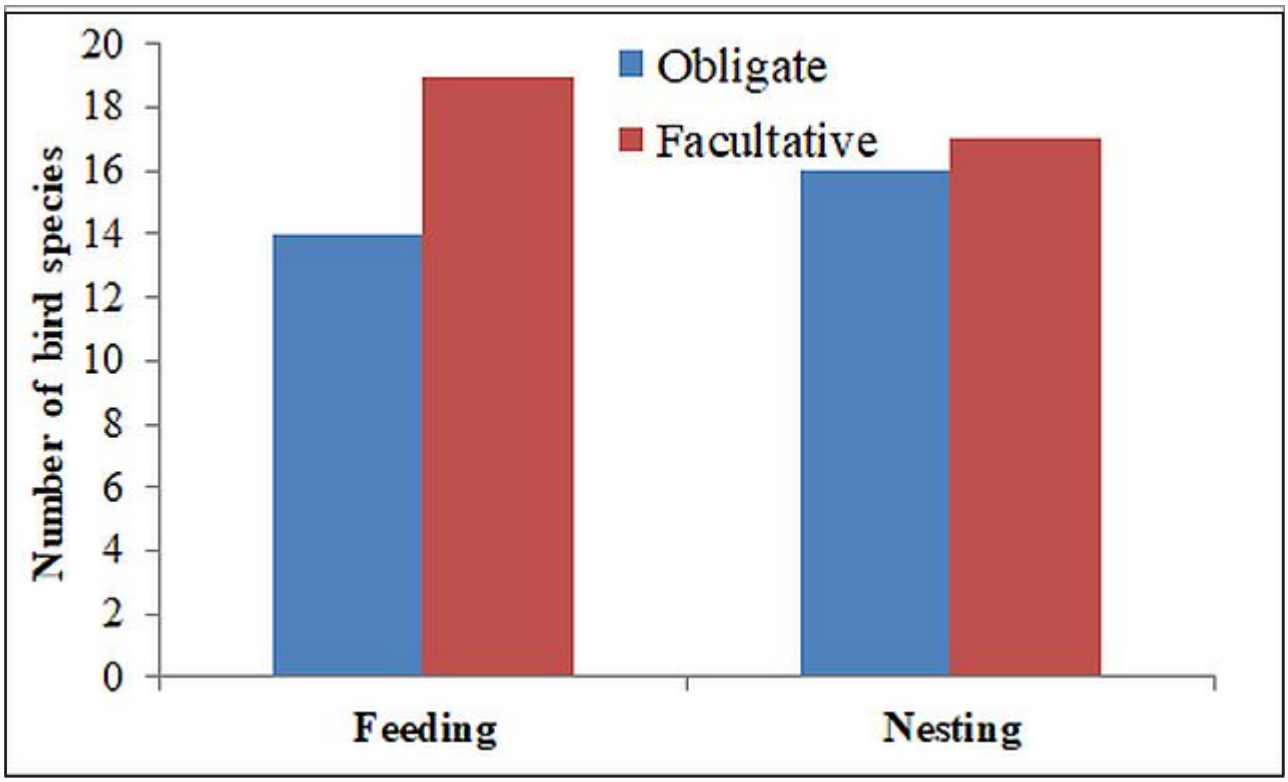


Figure 4. Associations of obligative and facultatively dependent birds on montane grassland for feeding and nesting

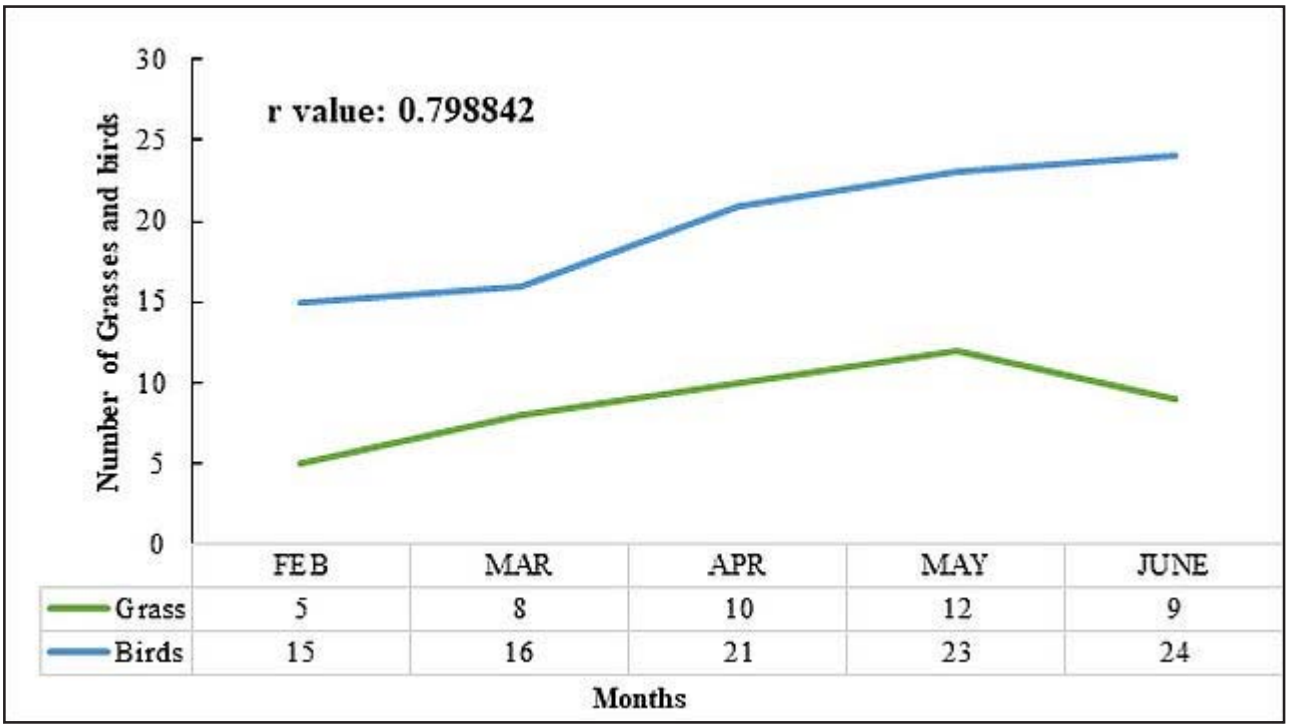


Figure 5. Pearson correlation between grass and bird

Gallus gallus (Linnaeus 1758)

Eudynamys scolopaceus (Linnaeus 1758)

Serinus pusillus (Pallas 1811)

Aegithalos concinnus (Gould 1855)

Lophura leucomelanos (Linnaeus 1766)

Pavo cristatus (Linnaeus 1758)

Photo Plate. Glimpses of avifauna of the Majathal Wildlife Sanctuary

CONCLUSIONS

This study has emphasized the importance of the subtropical montane grassland ecosystem as a crucial habitat for grassland-dependent birds. The composition of bird species in the grassland habitat is found to be impacted by many factors such as fire in the habitat, grazing pressure, and anthropogenic disturbances like developmental activities. Thus, the conservation of grassland birds requires management practices that ensure the perpetuation of grassland habitats. The present work provides baseline data regarding the composition and diversity of grassland birds and their association with different flora. It is hoped that this work will help to design proper strategies for the sustenance and preservation of grassland birds in MWLS.

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Conflict of interest: Authors declare no conflict of interest

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