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HIMALAYAS AND THE RANGE-RESTRICTED BIRDS: A REVIEW

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Abstract

The Himalayas, one of the world's most biodiverse regions, harbour numerous range-restricted bird species that are highly specialized to their unique ecological niches. This review synthesizes existing knowledge on the distribution, ecology, and conservation challenges of Himalayan birds with restricted ranges, emphasizing their vulnerability to environmental changes. Many of these species are confined to narrow elevational belts or specific habitat types, making them particularly sensitive to climate change, habitat degradation, and anthropogenic pressures. Studies indicate that rising temperatures are forcing upward range shifts, potentially leading to habitat contraction and increased extinction risk for high-elevation specialists. Additionally, deforestation, agricultural expansion, and infrastructure development further threaten these avian populations. Limited data on population trends and ecological requirements of many range-restricted species often hinder conservation efforts. However, community-based initiatives, protected area management, and climate-resilient habitat restoration show promise in safeguarding these birds. This review highlights key research gaps, including the need for long-term monitoring, genetic studies to assess population viability, and predictive modeling of range shifts under future climate scenarios. Strengthening regional collaboration among Himalayan countries is crucial for implementing effective transboundary conservation strategies. By integrating scientific research with policy interventions, it may be possible to mitigate threats and preserve the unique avian biodiversity of the Himalayas.

Keywords: Himalayas, range-restricted birds, climate change, habitat loss, conservation, endemic species

I. Introduction

The Himalayas are significant regarding global biodiversity hotspots, unique biogeographical aspects, steep altitudinal gradients, and overall ecological value (Myers et al., 2000). This mountainous landscape extends from subtropical foothills to alpine meadows to glacial environments, producing a habitat mosaic for plants and animals. These altitudinal gradients are essential in maintaining the diversity described in this region. The temperature and precipitation change with elevation lead to a series of different vegetation zones, ranging from subtropical forests at lower elevations to conifer forests, rhododendron thickets, and finally alpine meadows at extreme elevations (Rawal & Dhar, 2001; Kattel et al., 2015). Himalayas are home to a variety of mammals, birds, butterflies, reptiles and fishes. This ecological niche of vegetation allows for the housing of numerous species, many of which have specific adaptations for life in the unique environment of a particular elevation zone.

The avian fauna *i.e.* birds, which are an important part of the ecosystem, play a vital role in balancing the ecosystem as well as their sensitivity towards their habitat makes them a suitable biological indicator of climate change (Marriappan, 2013).

Approximately 9,000 bird species are known so far, out of which India accounts for about 1250 species, having approx. 14 percent of the world's total avian diversity (Kukreti and Kukreti, 2015). The records suggested that the Himalayan region has around 980 bird species, out of which 35 bird species are endemic to the Himalayan region and 11 to the Western Himalayas. Based on endemism, the Himalayan region is divided into 2 Endemic Bird Areas (EBA's) that are critical regions of world for the conservation of restricted-range bird species: 128 EBA (Western Himalayas) and 130 EBA (Eastern Himalayas) in which 128 EBA supports 55 IBAs and 130 EBA supports 90 IBAs (Collar et al. 2001).

The Western Himalayas are also known for their endemism; many species in this region are not found anywhere else on the planet (Joshi & Bhatt, 2015; Salick et al., 2014; Wani et al., 2023). This endemism is the result of the long evolutionary history, geographical isolation, and diverse topographical features of the region, which promote the development of different unique adaptations and species diversification. The isolation of the region has also fostered the evolution of those unique evolutionary lineages, thus making this region a valuable area for conservation. Additionally, the Western Himalayas are also significant for influencing the regional climate and hydrology. The region is rich in glaciers and snowpack, which are local water sources to downstream communities, and the forests are useful for carbon sequestration and soil retention (Manandhar and Rasul, 2009; Romshoo et al., 2022; Shrestha et al., 2012). The ecological integrity of the Western Himalayas is therefore key, not only for the conservation of endemic biodiversity but also for the livelihood of millions of people who rely on this ecosystem (Hughes, 2017; Mikula et al., 2023; Steven & Castley, 2013). This biodiversity hotspot is subjected to threats from climate change, habitat degradation and other anthropogenic pressures, warranting further focused research and conservation-based activities. Understanding distribution patterns and ecological requirements for range-restricted species in the Western Himalayas becomes crucial when considering conservation mechanisms for identified species.

II. Concept of Range-Restricted Species and Their Importance in Conservation

The range-restricted species are organisms with geographic distribution confined to a small area due to ecological, evolutionary, or geographical constraints (Shreshtha et al., 2019). Range-restricted species are often associated with specialized habitats, which makes them highly susceptible to environmental and human-induced changes. They are often associated with specific climatic, edaphic, or biotic combinations that limit their dispersal and survival outside their native range (Jetz et al., 2004; Casazza et al., 2014; Szabo et al., 2009). Several reasons make conservation for range-restricted species particularly important. Range-restricted species are especially vulnerable to habitat destruction, climate change, and invasive species due to their small range size (Brooks et al., 2002). The minimal environmental changes can drastically alter their population size, leading to rapid declines to extinction (Pimm et al., 2014). Many species among the range-restricted are currently classified as endemic, which means they cannot exist anywhere else on earth (Myers et al., 2000). Such species enrich global biodiversity concentrated in biodiversity hotspots, i.e., areas of high species diversity and endemism with increasing threats (Mittermeier et al., 2004). Typically, the range-restricted species have some very critical ecological functions within their habitats, like pollinators, seed dispersers, or other key elements sustaining the ecosystem (Gaston and Fuller, 2009; Primack, 2012; Díaz et al., 2013). When those species are lost, ecological processes get disrupted, which in turn harms other organisms existing in that ecosystem. As range-restricted species are sensitive to environmental changes, they are amongst the first indicators of habitat degradation and climate shifts that could cause population decrease or, in the worst cases, extinction (Thomas et al., 2004). Surveillance of these populations can yield valuable information regarding the health of an ecosystem and can guide conservation strategies. In general, conservation initiatives for species with restricted geographic ranges normally entail protecting and restoring ecosystem habitat, as well as institutional protections aimed at reducing anthropogenic threats. The creation of protected areas, ex-situ conservation methods, which include captive rearing or ecological research, are potentially necessary for the continued survival of these species (Rodrigues et al. 2004).

III. Range-restricted birds of the Himalayas

The Western Tragopan (*Tragopan melanocephalus*), a vulnerable pheasant species endemic to the Western Himalayas, occurs in the Indian states of Himachal Pradesh and Uttarakhand and portions of the Pakistani-administered Kashmir (BirdLife International, 2023). It inhabits temperate coniferous forests, a mix of broadleaf-coniferous forests, and alpine scrub, between 2400 and 3600 meters above sea level. The range is very fragmented, with isolated populations occupying smaller patches of suitable habitat (Singh et al., 2020). The Himalayan Monal is a more abundant pheasant that occurs across the Himalayan range, including the Western Himalayas. The Himalayan Monal (*Lophophorus impejanus*) occurs throughout the altitude range of 2100 to >4500 m in alpine meadows, scrub forests, and rhododendron associations. However, the range of the Himalayan Monal, although generally greater than that of the Western Tragopan, has also locally remained somewhat vulnerable to habitat loss and fragmentation. The Cheer Pheasant (*Catreus wallichii*) is another vulnerable pheasant species found in the Western Himalayas, especially in the states of Himachal Pradesh and Uttarakhand in India, but also in some regions of Nepal and Pakistan. Speeds are on steep, rocky slopes with

scattered scrub and grassland between 1,500 and 3,000 meters above sea level. The species is massively fragmented and has suffered very large declines in its populations (Singh et al., 2023). Sclater's Monal (*Lophophorus sclateri*) occurs in the eastern Himalayas and has a western-most distribution in the western parts of the Himalayan region, particularly around the borders with Nepal and India. A bird that inhabits high-altitude rhododendron scrub, coniferous forests, and alpine meadows (BirdLife International, 2023).

IV. Factors Influencing Distribution Patterns of Range-Restricted Birds of the Himalayas

The conversion of forests into agriculture, infrastructure, and timber extraction has led to an extreme increase in habitat fragmentation, isolating populations and disrupting gene flow. This is crucial for forest-dependent species like the Western Tragopan and the Himalayan Forest Thrush (Ahmad et al., 2023). An unnatural removal of forest vegetation has occurred due to extensive grazing by livestock, which is harming many animals like the Cheer Pheasant and the White-throated Tit (IUCN, 2023). For high-altitude species like the Himalayan Monal and Sclater's Monal, range contraction and habitat sullying are probably the results of changing vegetation zones brought on by rising temperatures and altered precipitation patterns (Sharma et al., 2023).

Table 1- List of range restricted bird species of the Himalayas

Species Name	Distribution	Conservation Status	Reference
Western Tragopan (*Tragopan melanocephalus*)	Himalayas (India, Pakistan)	Vulnerable	Singh et al., (2020).
Cheer Pheasant (*Catreus wallichii*)	Himalayas (India, Nepal, Pakistan)	Vulnerable	Singh et al., (2023).
Himalayan Quail (*Ophrysia superciliosa*)	Western Himalayas (Uttarakhand)	Critically Endangered (Possibly Extinct)	BirdLife International. (2023).
Sclater's Monal (*Lophophorus sclateri*)	Eastern Himalayas (India, China, Myanmar)	Vulnerable	BirdLife International. (2023).
Himalayan Monal (*Lophophorus impejanus*)	Himalayas (India, Nepal, Bhutan)	Least Concern (but locally vulnerable)	BirdLife International. (2023).
Himalayan Griffon (*Gyps himalayensis*)	Himalayas	Near Threatened	BirdLife International. (2023).
Brooks's Leaf-Warbler (*Phylloscopus subviridis)*	Himachal Pradesh	Least Concern	BirdLife International (2019)
Kashmir Flycatcher (*Ficedula subrubra)*	Breeds in Kashmir, winters in Sri Lanka	Vulnerable	BirdLife International. (2023)
Tytler's Leaf-Warbler (*Phylloscopus tytleri)*	Breeds around Western Himalayas, winters in South India	Near Threatened	BirdLife International (2019)
Kashmir Flycatcher (*Ficedula subrubra)*	Breeds in Western Himalayas, winters in South India and Sri Lanka	Vulnerable	BirdLife International (2019)
White-cheeked Tit (*Aegithalos leucogenys)*	Afghanistan, India & Pakistan	Least Concern	BirdLife International (2019)
White-throated Tit (*Aegithalos niveogularis)*	India, Nepal & Pakistan	Least Concern	BirdLife International (2019)

Kashmir Nuthatch (*Sitta cashmirensis)*	Jammu & Kashmir	Least Concern	BirdLife International (2019)
Spectacled Finch (*Callacanthis burtoni)*	Western Himalayas	Least Concern	BirdLife International (2019)
Orange Bullfinch (*Pyrrhula aurantiaca)*	Western Himalayas	Least Concern	BirdLife International (2019)

Human Disturbance, such as illegal hunting and trapping for meat, plumage, or the pet trade, continues to pose threats, particularly for pheasant species (BirdLife International, 2023). Tourism and infrastructure development can disturb breeding sites and displace sensitive species like the Kashmir Flycatcher (Kumar et al., 2024). Many species restricted geographically display distinct preferences for certain habitats, which confine their distribution to specific altitudinal zones, forest types, or microhabitats. The Himalayan Griffon is dependent upon large mammal carcasses as its food source, thus limiting its distribution based on prey availability (Baral and Gautam, 2007; Moreno-Opo et al., 2010). Biogeographical factors such as altitude gradients in the Himalayas create a mosaic of habitats, direct species coexistence, and high levels of endemism. Geological structures, particularly mountain ranges and river valleys, whisk away the close contact of species across altitudinal gradients, giving way to geographic barriers that impede gene flow (Alström et al., 2016).

V. Protected areas and habitat preservation

To conserve range-restricted bird species in the Western Himalayas, an integrated, science-based, community-engaged conservation attitude is needed to effectively enable future action. The creation and effective management of protected areas (i.e., national parks, wildlife sanctuaries, and conservation reserves) is very important to protect habitat for many rare and endemic bird species. For example, the Great Himalayan National Park (GHNP), World Heritage Site (2021) in Himachal Pradesh, includes several altitudinal zones and has populations of the Western Tragopan and Cheer Pheasant. Protected areas provide secure breeding habitats and areas free from disturbance, while also serving as genetic banks (Premlata et al., 2024). The mere existence of protected areas is not enough. Active management, such as habitat restoration, careful tourist management, and strict anti-poaching is needed to maintain the integrity of the ecosystem and limit human impact. Local communities play an indispensable role in the conservation process in the Himalayas, as they rely on forest resources and often live adjacent to wildlife areas. Community-based conservation acknowledges the role of local communities in conservation initiatives and, whenever possible, employs participatory methods to incorporate local knowledge systems, traditions, and livelihoods into conservation that may be feasible and beneficial for local stakeholders. For example, community-based conservation programs of the Western Himalayas have had significant success with: Establishing eco-development committees for stewardship, promoting sustainable practices related to harvesting of non-timber forest products (NTFP), providing training and job opportunities for local stewards in such programs as biodiversity monitors or eco-guides. These community conservation programs will not only empower local communities but also minimize human-wildlife conflict and increase stewardship of biodiversity (Premlata et al., 2024). These types of initiatives illustrate an opportunity for conservation outcomes. Outcomes improve greatly when

individuals who live within and surrounding biodiversity hotspots are supporters and collaborators rather than threats. Ecotourism has become a double-edged sword, providing a positive source of socioeconomic eco-benefit to local communities while improving understanding of conservation objectives. Ecotourism, with good management practices, can earn income through wildlife viewing and birding tours. Fund restoration and research activities for wildlife habitat. Create support for the protection of species through community residents. At the same time, environmental education programs for schools, youth, and even tourists, can help create a conservation ethic. Interpretive centres, nature trails, and cultural exchanges have been shown to establish connections between human well-being and biodiversity health (Premlata et al., 2024). The principal law for wildlife conservation is the Wildlife Protection Act of 1972 (India), which covers all wildlife, including species that are endangered and/or range restricted. This Act: Prohibits hunting, poaching and trade in listed species. Legally designates protected areas. Lists species in various schedules by conservation priority. For example, birds such as the Western Tragopan are listed under Schedule I, thus offering them the highest level of protection. In addition, other international conventions such as CITES or the Convention on Biological Diversity (CBD) provide further protection through trade regulations and habitat conservation across jurisdictions. Despite comprehensive legal protection offered to wildlife, wildlife protection continues to be a challenge due to the lack of personnel, budget, and means to enforce laws in remote regions (Premlata et al., 2024). To improve long-term wildlife conservation, it is important to enhance these legislative frameworks and improve cooperation between agencies.

VI. Future directions and research needs

Even though understanding of Himalayan avifauna has advanced significantly, there are still important knowledge gaps that necessitate immediate interdisciplinary research. It is still challenging to measure climate-driven elevational shifts for endemic species, particularly in the Himalayas, where detecting microclimatic refugia is essential to predict survival in warming scenarios (Aryal et al., 2016). Future research must prioritise the identification of climate refugia for Himalayan birds that are restricted in their range, particularly when using high-resolution satellite data and species distribution modelling. It is essential to integrate rigorous applied research and anticipatory spatial planning with conservation action, to optimize chances of long-term survival for range-restricted species in the Western Himalayas.

Rapidly changing climate and landscapes in the region require a rigorous scientific basis for understanding, forecasting, and mitigating biodiversity loss (Elith & Leathwick, 2009). Species distribution models (SDMs) leverage environmental variables (e.g., temperature, precipitation, elevation, vegetation), to project appropriate habitats in the present and future for species of interest. Models are critical for species with restricted ranges because they help to identify climate refugia, migration corridors and potential release sites. For example, Singh et al. (2020) modelled the habitat of the Western Tragopan and reported a significant contraction in their modelled habitat under future climate projections. Studies of this nature have the potential to be extremely valuable in a proactive conservation planning context, allowing conservation practitioners to prioritize areas for habitat protection and restoration before experiencing critical declines.

It is crucial for adaptability and persistence over the long term that species populations express genetic diversity in their gene pool. In terms of species populations with restricted ranges or fragmented populations, such as Cheer Pheasant and Himalayan Forest Thrush, population genetics can reveal levels of inbreeding. Uncover isolated populations that are at risk of undergoing a genetic bottleneck assist development of managed breeding and translocation programs Singh et al. (2020) note that genetic studies can even take the step to map population structure and gene flow which can be essential in developing biological corridors that join isolated habitat patches (Frankham et al., 2010).

The Himalayas are very sensitive to climate change, like an increase in temperature, the disappearance of glaciers, and changes in precipitation regimes can impact: Phenology (timing of breeding and migration), drastic vegetation zone changes (reducing habitat availability), changes in altitude (forcing species to move to higher elevations where space allows). For high-altitude species, like Sclater's Monal or Himalayan Monal, shrinking alpine meadows will likely lead to range contractions. Climate change impact assessments can also help to predict possible range shifts and guide adaptive management (Parmesan & Yohe, 2003). Likewise, to study habitat fragmentation, long-term data is needed to be assessed in which the impact of infrastructure projects and road constructions on range-restricted species like Satyr Tragopan could also be studied (Chhetri et al.2018; Thinley, 2017). It is important to utilise the developments in bioacoustics as well, to evaluate the invisible decline in the avifaunal population (Laiolo,2010).

While short-term studies provide a snapshot or extended use, research is necessary for a long-term monitoring approach to look for population trends, habitat degradation, and benefits or negative effects of conservation to be insightful over time. Lindenmaye & Likens (2010), recommend setting up permanent monitoring plots, automated bird call stations, and citizen science strategies in the Western Himalayas, which can highlight early signs of species declines and allow for prompt management actions, in the wildlife community.

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