

Assessing Avian Biodiversity and Conservation Challenges in A Semi-Arid Hill Ecosystem: A Case Study from The Harsh-Jeen Region

Abhishek Rollan¹, Dr. Nisha Siroya², Dr. A. K. Siroya³

¹Research scholar, Department of Zoology, S.P.C. Govt. College, Ajmer (Rajasthan)

²Associate Professor, Department of Zoology, S.P.C. Govt. College, Ajmer (Rajasthan)

³Professor, Department of Zoology, S.P.C. Govt. College, Ajmer (Rajasthan)

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ABSTRACT

It is critical for conservation to comprehend how elevation affects avian biodiversity, particularly in ecologically delicate and little understood semi-arid areas. In this study, the HARSH-JEEN hills of Rajasthan, which are a component of the Aravalli range, are examined for their bird population composition, distribution patterns, and anthropogenic stresses along an elevation gradient (350–800 m). We documented 42 families and 122 species using routine field surveys conducted throughout the year using line transect and point count techniques. The species richness distribution was unimodal, peaking at mid-elevations (500–650 m). Elevation specialists included a number of species of conservation interest. Zones of high religious tourism and vegetation loss were found to be significantly fragmented in low- and mid-elevation zones, according to a GIS-based land cover analysis. Initial community interviews also revealed a decline of traditional management and an increase in anthropogenic hazards. The necessity of site-specific conservation strategies, such as habitat zoning, community-based stewardship models, and sustainable ecotourism activities, is highlighted by the present research. A reproducible model for comparable dryland hill ecosystems throughout the Aravalli region is provided by these results.

Keywords: Avian biodiversity, HARSH-JEEN hills, Semi-arid ecosystem, Species richness, Habitat fragmentation, GIS mapping, Community perception, Rajasthan birds, Conservation strategy.

INTRODUCTION

Particularly in areas that are under environmental stress, research on elevation-driven biodiversity patterns is critical for understanding ecological processes, species distribution, and conservation planning (Rahbek, 2005).

Mountains provide a unique chance to study these patterns because of their diverse flora kinds and microclimates. However, dry and semi-arid mountain systems have not received enough attention in this study, with most of it concentrating on tropical and temperate regions (Price *et al.*, 2011).

A semi-arid hill habitat, the HARSH and JEEN hills are situated in Rajasthan, India's Sikar district and are a component of the Aravalli range. Scrublands, grasslands, scant woods, and places of worship are among the many ecosystems found on these hills. Both permanent and few migratory species may be supported by a diverse avifaunal population because of their elevation variety and isolation. The richness of birds in this area is still not well recorded, despite its ecological significance. Furthermore, human activities like religious tourism, deforestation, grazing is putting more and more strain on the region. Our work closes this gap by evaluating bird biodiversity across height gradients in the HARSH-JEEN highlands and identifying critical conservation issues. Examine the functions of particular native bird species in the ecology of the HARSH-JEEN hills. Examine the ways that religious tourism affects environmental preservation and deterioration.

Discuss about the connection between the region's declining bird population and forestry practices. Provide ideas for how to engage nearby communities in conservation initiatives to save the species of birds. Emphasize the importance of HARSH-JEEN hills and effective case studies of conservation initiatives in related natural zones.

OBJECTIVES:

- To examine the patterns of bird species richness and diversity at various height gradients in the HARSH-JEEN hills.
- To identify species that are specialized or restricted by elevation and investigate the distribution of key bird taxa in altitudinal niches.
- To quantify the relationship between seasonal changes in avifaunal diversity and habitat shape and elevation.
- To assess the effects of human activities on bird diversity at various elevations, such as habitat fragmentation, land-use change, and religious tourism.
- To identify the Strategies conserve to semi-arid hill environments.

LITERATURE REVIEW

Elevation and Biodiversity Patterns: Global Foundations

Ecologists have long recognized the significance of elevation in shaping biodiversity patterns, treating elevational gradients as natural laboratories for exploring how temperature, precipitation, and vegetation structure influence species distribution (McCain, 2009; Rahbek, 1995).

These gradients offer valuable insights into how climatic variables interact with topography to shape species richness and composition. Environmental factors such as productivity, humidity, and habitat heterogeneity are key drivers of these elevational biodiversity patterns (Colwell & Lees, 2000; Körner, 2007)

In recent decades, climate change has emerged as a major factor influencing species distributions along elevational gradients. A growing body of research indicates that many species, particularly birds, are shifting their ranges upward in response to warming temperatures (Forero-Medina *et al.*, 2011; Freeman *et al.*, 2018).

These shifts are particularly pronounced in tropical regions where narrow thermal belts restrict lateral movement, forcing species to ascend to suitable climates. However, for many tropical mountain species with narrow altitudinal ranges, this "escalator to extinction" poses significant threats due to limited habitat at higher elevations (McCain, 2009).

Scale and Spatial Context in Biodiversity Studies

The importance of spatial scale in studying species richness has been widely acknowledged (Rahbek, 2005) emphasized the necessity of fine-scale, site-specific studies, especially in underrepresented ecosystems such as dryland mountain regions. These environments often overlooked in broad-scale conservation assessments, harbour unique species assemblages adapted to extreme and fluctuating conditions.

Indian Context: Conservation in Major and Overlooked Ranges

In India, much of the ornithological focus has traditionally been on the Himalayas and the Western Ghats-regions known for their rich biodiversity and endemic bird populations (Davidar *et al.*, 2001; A. Rahmani *et al.*, 2004).

These studies have laid the foundation for understanding the structure and threats to avian communities in humid mountain systems. However, more recent efforts have begun to spotlight semi-arid and dryland mountain systems, particularly those with socio-cultural importance such as sacred groves. This Studies in highlight how Rajasthan's semi-arid landscapes-including the Aravalli range-support unique avifaunal diversity (Joshi *et al.*, 2021; Kumar & Koli, 2024).

These regions combine climatic harshness with ecological resilience, creating niches for specialized bird communities. Importantly, many of these species exhibit altitudinal specialization, limiting their distributions to narrow elevation bands and increasing their vulnerability to environmental changes (McCain, 2009).

The HARSH-JEEN Hills: A Neglected Biodiversity Frontier

The Aravalli hills, among the oldest mountain systems in India, remain underrepresented in ornithological literature despite their ecological and geological importance. Recent studies suggest that a variety of bird species that are suited to both dry and elevated environments may be found in the HARSH-JEEN hills, which are a component of the Aravalli range. However, no recent scientific evaluations have looked closely at this field, leaving information gaps that prevent avian bird conservation.

Anthropogenic pressures, including religious tourism, agricultural expansion, and deforestation, exacerbate the vulnerability of dryland mountain birds. These human impacts often overlap with areas of high avian diversity, intensifying conservation challenges. According to this study dryland mountain forests require location-specific protection strategies due to their heightened susceptibility to such threats (Price *et al.*, 2011).

Biotic Interactions and Elevational Shifts:

The importance of biotic interactions in determining bird diversity over elevational gradients has been brought to light by recent research. In the Indian mountain ranges, competition from *Oecophylla* ants at lower elevations is forcing insectivorous birds to higher altitudes, according to a 2024 research from the Indian Institute of Science. This change highlights the intricate relationship between species interactions and elevational distribution, indicating that both biotic and abiotic variables play a significant role in generating patterns of species richness in mountainous areas (Srinivasan *et al.*, 2024).

Climate-Induced Population Dynamics in Tropical Mountains:

This research, which was carried out on KENYA's MT. KASIGAU between 2011 and 2023, found that although several bird populations were constant, certain species had notable drops in 2015 and 2022. The fact that these variations were ascribed to environmental in the weather showed how susceptible tropical mountain birds are to changes in the climate. The results highlight the significance of on-going observation in order to comprehend and lessen the effects of climate change on mountain avifauna (Wambugu *et al.*, 2025).

Anthropogenic Threats: Logging and Habitat Degradation:

According to this study, which was carried out in the Eaglenest Wildlife Sanctuary in Arunachal Pradesh, India, logging lowers biodiversity overall and causes the extinction of large-bodied birds that depend on old growth. The decline in foliage-dwelling insect populations in logged forests has a particularly negative impact on understory insectivores, which are niche-dependent. The results highlight how crucial it is to protect primary forests in order to lessen the impact of climate change on montane bird species (Chanda *et al.*, 2023).

Conservation Frameworks and National Policy Insights:

The identification of Important Bird Areas (IBAs) under human stress has reinforced the need for evidence-based conservation interventions (A. Rahmani *et al.*, 2004).

More recently, study have emphasized the role of birds as ecological indicators and cultural symbols, making them ideal subjects for assessing the health of ecosystems. The State of India's Birds report provides detailed

assessments of distribution, abundance, and threat levels across species, offering a comprehensive framework for national-level conservation efforts. (A.R.Rahmani, 2022; Rahul Kishore Talegaonkar, 2023).

The Way Forward: Filling Gaps through Site-Specific Research:

This research in note, arid regions often shows high variability in bird abundance and diversity. Some species may dominate particular habitats while others remain scarce, making habitat-specific studies critical (Sivaperuman *et al.*, 2009).

The HARSH-JEEN hills exemplify such complexity. Despite their potential as biodiversity hotspots, they lack sufficient ornithological data. By integrating elevation data, biodiversity trends, and anthropogenic pressures, the present study aims to bridge this knowledge gap and contribute to evidence-driven habitat management in dryland mountain ecosystems.

METHODOLOGY

Study Area:

The HARSH and JEEN hills, which are between 350 and 800 meters high, are situated in Rajasthan's Sikar district. Seasonal monsoon rains have an impact on the area's dry deciduous woodland, scrublands, grasslands, and agricultural regions.

Ecosystems Surveys:

- Dry deciduous forest
- Throne scrublands
- Grasslands
- Agro-ecosystems
- Pilgrimage-influenced zones

Sampling Design:

- **Time Frame for the Survey:** January–December 2024
- **Elevation zones:** Low (350–500 m), Mid (500–650 m), and High (650–800 m).
- **Methods:** **Point Count:** Fixed-radius 10-minute surveys.
 - **Line Transects:** 1 km surveyed routinely across seasons.
 - **Total Efforts:** 180-point counts, 90 transect surveys across the year.

Community Interviews:

Semi-structured interviews (n = 25) were conducted with local residents, temple staff, and forest personnel to understand:

- Traditional knowledge of birdlife
- Perceived threats
- Opinions on conservation measures

GIS and Remote Sensing: Tools Used Sentinel-2 satellite data, QGIS

- Analyses: NDVI to assess vegetation cover, Land-use classification (forest, scrub, agriculture, built-up).
- Fragmentation metrics: patch size, edge density. Spatial overlays were applied to survey zones to assess correlation with bird diversity metrics.

Data Analysis:

- Indexes of species diversity, abundance, and richness (Shannon, Simpson)
- The regression and ANOVA for analyzing elevation patterns.
- IUCN Red List-based conservation status.

RESULT AND DISCUSSION

Table 1: Avian Diversity Indices across Elevation Zones in Harsh- Jeen Hills:

Elevation Zone	Species Richness	Shannon Index	Simpson Index
Low (350–500 m)	61	2.89	0.87
Mid (500–650 m)	78	3.61	0.94
High (650–800 m)	67	3.12	0.90

Model	R ²	p-value	Interpretation
Species Richness~ Elevation	0.62	< 0.01	Significant positive correlation between elevation and species richness, peaking at mid-elevation.

Table 2: Regression Analysis:

The regression confirms elevation as a major factor influencing avian richness, supporting the mid-domain hypothesis.

In overall altitude zones, 122 bird species from 42 families are identified throughout the year-long investigation. In contrast to 61 species at low altitudes (350–500 m) and 67 species at high altitude (650–800 m), species richness exhibited a single-modal distribution, peaking at mid-elevations (500–650 m) with an average of 78 species. This distribution supports the mid-domain effect hypothesis, which predicts a richness peak at intermediate altitudes. Higher elevations were home to rarer and more specialized species, whereas lower elevations were dominated by generalists. Taxa with elevation restrictions showed significant niche difference.

There is clear seasonal fluctuation, with migratory species such as the pink starling showing up in the winter. Bird communities in lower and mid-elevation zones are negatively impacted by human pressures including

tourism, deforestation, and land-use change. By showing how elevation affects species distribution, identifying important species with limited altitudinal ranges, recording seasonal variations, and connecting human-induced changes to biodiversity decrease, the findings support the goals of the study. These results support the necessity of context-based conservation strategies and highlight the ecological vulnerability of semi-arid hill ecosystems. Low altitudes had the lowest diversity indices (Shannon Index: 2.89; Simpson Index: 0.87), whereas middle elevations had the greatest (Shannon Index: 3.61; Simpson Index: 0.94). The mid-zone contains more heterogeneous communities and a more uniform distribution of species. Elevation was significantly correlated with species richness, according to regression analysis ($R^2 = 0.62$; $p < 0.01$).

Table 3: Avian Species Observed in the Harsh-Jeen Region

S. N.	Common Name	Scientific Name	IUCN Status	Elevation Range	Migratory Status	Habitat Type
1	Indian Peafowl	<i>Pavo cristatus</i>	Least Concern	Low to High	Resident	Scrubland Forest
2	Rose-ringed Parakeet	<i>Psittacula krameri</i>	Least Concern	All Zone	Resident	Urban, Agricultural
3	Common Myna	<i>Acridotheres tristis</i>	Least Concern	Mid to High	Resident	Urban, Agricultural
4	Black Drongo	<i>Dicrurus macocerus</i>	Least Concern	Low to High	Resident	Farmland, Open Areas
5	Red-vented Bulbul	<i>Pycnonotus cafer</i>	Least Concern	All Zone	Resident	Forest Edge
					Resident	

6	Indian Robin	<i>Saxicoloides fulicatus</i>	Least Concern	Mid to High		Rocky Areas, Grassland
7	Green Bee-eater	<i>Merops orientalis</i>	Least Concern	Low to Mid	Resident	Open Areas
8	House Sparrow	<i>Passer domesticus</i>	Least Concern	All Zones	Resident	Urban, Rural
9	Common Hoopoe	<i>Upupa epops</i>	Least Concern	Mid	Resident	Scrubland Grassland
10	Rosy Starling	<i>Pastor roseus</i>	Least Concern	Low	Winter Migrant	Agricultural Fields
11	Ashy Prinia	<i>Prinia socialis</i>	Least Concern	Low to Mid	Resident	Bushland
12	Jungle Babbler	<i>Turdoides striata</i>	Least Concern	All Zones	Resident	Forest, Village Edges
13	Brahminy Starling	<i>Sturnia pagodarum</i>	Least Concern	Mid	Resident	Grassland, Farmlands
	White-	<i>Halcyon</i>			Resident	

14	throated Kingfisher	<i>smyrnensis</i>	Least Concern	All Zones		Dry Deciduous Forest
15	Indian Grey Hornbill	<i>Ocyrceros birostriss</i>	Least Concern	Low	Resident	Dry Deciduous Forest
16	Coppersmith Barbet	<i>Psilopogon haemacephalus</i>	Least Concern	Low	Resident	Urban Tress
17	Spotted Dove	<i>Spilopelia chinensis</i>	Least Concern	All Zones	Resident	Urban Agriculture
18	Laughing Dove	<i>Spilopelia senegalensis</i>	Least Concern	All Zones	Resident	Farmlands, Scrubland
19	Shikra	<i>Accipiter badius</i>	Least Concern	Low to Mid	Resident	Forest, Open Areas
20	Indian Roller	<i>Coracias benghalensis</i>	Least Concern	All Zones	Resident	Open Woodlands
					Resident	

21	Black Kite	<i>Milvus migrans</i>	Least Concern	All Zones		Urban Scavenging Areas
22	Eurasian Collared Dove	<i>Streptopelia decaocto</i>	Least Concern	All Zones	Resident	Urban Semi-Urban
23	Rufous Treepie	<i>Dendrocitta vagabunda</i>	Least Concern	High	Resident	Dry Forests
24	Indian Silverbill	<i>Euodice malabarica</i>	Least Concern	Low	Resident	Grassland, Agricultural
25	Greater Coucal	<i>Centropus sinensis</i>	Least Concern	Low to Mid	Resident	Dense Shrubs, Farmland
26	Tickell's Blue Flycatcher	<i>Cyornis tickelliae</i>	Least Concern	Mid	Resident	Forested Streams
27	Brown Rock Chat	<i>Oenanthe fusca</i>	Least Concern	High	Resident	Rocky Terrain
28	Pied Bushchat	<i>Saxicola</i>	Least Concern	Mid to	Resident	Farmlands

		<i>caprata</i>		High		
29	Oriental Magpie Robin	<i>Copsychus saularis</i>	Least Concern	All Zones	Resident	Gardens, Forests
30	Common iora	<i>Aegithina tiphia</i>	Least Concern	Low to Mid	Resident	Forest Edge Scrub
31	Indian Paradise Flycatcher	<i>Terpsiphone paradisi</i>	Least Concern	Mid to High	Summer Visitor	Forest Canopy
32	Bay-backed Shrike	<i>Lanius vittatus</i>	Least Concern	Low	Resident	Agricultural fields
33	Long-tailed Shrike	<i>Lanius schach</i>	Least Concern	Mid	Resident	Open Scrubland
34	Red-wattled Lapwing	<i>Vanellus indicus</i>	Least Concern	Low to Mid	Resident	Water Bodies
35	Little Egret	<i>Egretta garzetta</i>	Least Concern	Low	Resident	Marshes

						Wetland
36	Indian Pond Heron	<i>Ardeola grayii</i>	Least Concern	Low	Resident	Wetlands Fields
37	Grey Francolin	<i>Francolinus pondicerianus</i>	Least Concern	Low to Mid	Resident	Grassland, Agricultural
38	Painted Stork	<i>Mycteria leucocephala</i>	Least Concern	Low	Resident	Wetlands
39	Common Kestrel	<i>Falco tinnunculus</i>	Least Concern	High	Winter Visitor	Rocky Slopes
40	Crested Serpent Eagle	<i>Spilornis cheela</i>	Least Concern	Mid	Resident	Woodland, Hills
41	Yellow-eyed Babbler	<i>Chrysomma sinense</i>	Least Concern	Low	Resident	Scrub, Grassland

Visual Data Representations

Chart 1: Seasonal Diversity Trends (Shannon Index):

The line graph illustrates seasonal variations in bird diversity (Shannon Index) across the three elevation zones. Bird diversity was consistently highest in the mid-elevation zone, especially during the monsoon and winter seasons. The low and high zones showed more fluctuation, suggesting higher sensitivity to seasonal changes.

Chart 2: Species Richness Across Elevation Zones

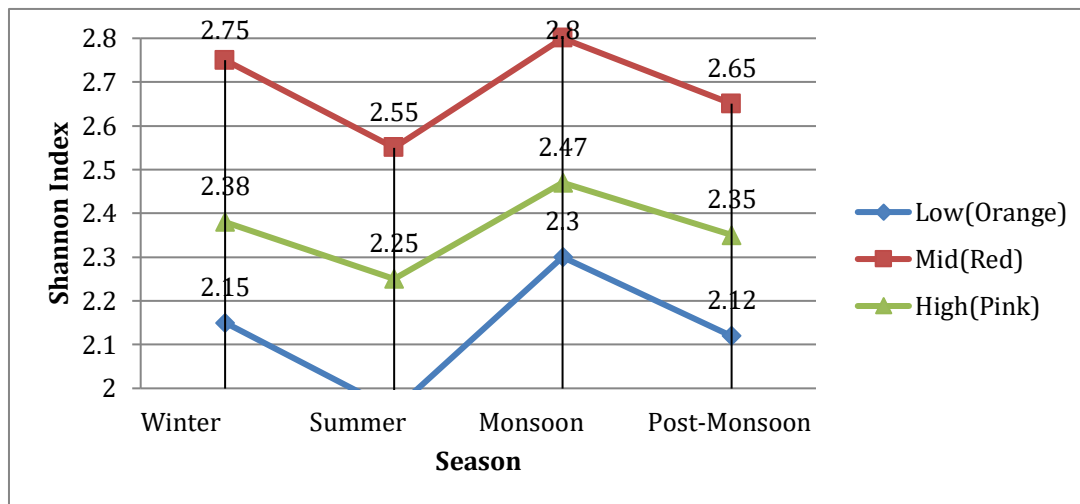


Figure 1. Seasonal Diversity harsh jeen

Chart 2: Species Richness Across Elevation Zones:

This bar chart displays the total number of bird species recorded across three elevation zones in the HARSH-JEEN hills. Species richness peaked at the mid-elevation zone (500–650 m) with 78 species, followed by the high zone (67 species) and the low zone (61 species). This pattern supports a unimodal distribution, often seen in elevation biodiversity studies.

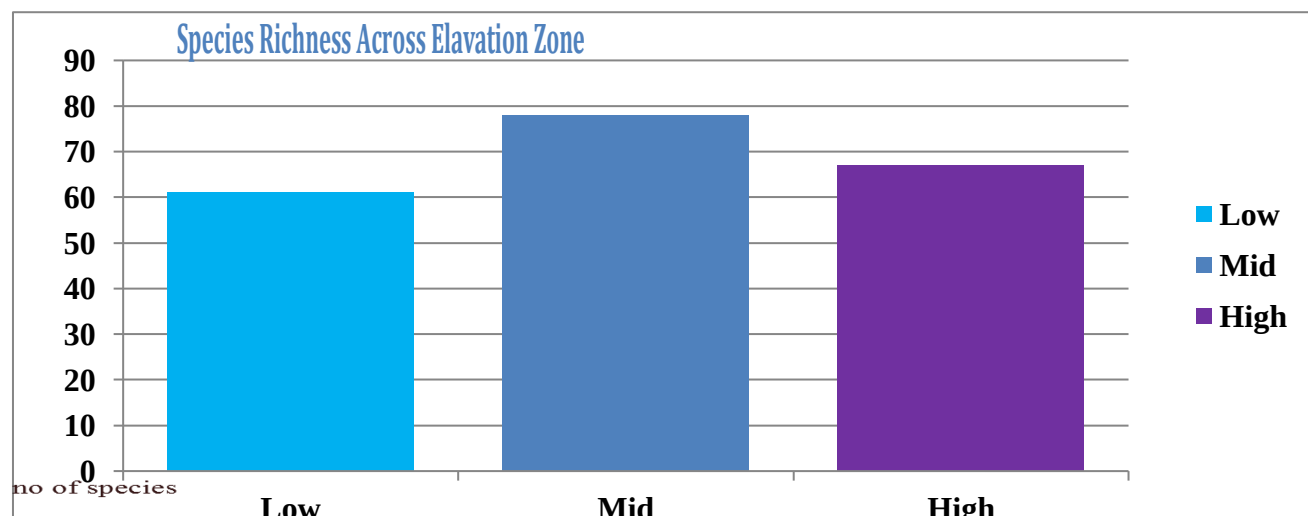


Figure 2. Species Richness Across Elevation Zones

Chart 3: Land Use Classification by Elevation Zone

This stacked bar chart shows the proportion of land cover types—forest, scrubland, agriculture, and built-up area—across elevation zones. The low zone is heavily influenced by agriculture and built-up areas, while the

mid and high zones are dominated by forest and scrubland. This gradient reflects how land-use intensity decreases with elevation, aligning with observed patterns of habitat disturbance.

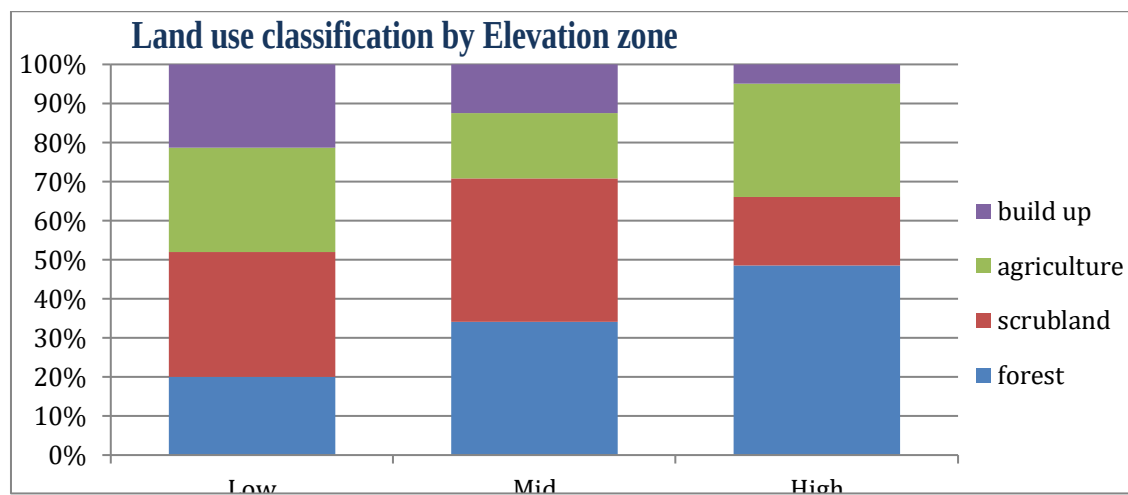


Figure 3. Land Use Classification by Elevation Zone

Chart 4: Community Perception of Threats

The pie chart summarizes local community responses (n=25) regarding perceived threats to bird populations. Habitat loss was the most cited concern (35%), followed by tourism pressure (25%), forest clearance (20%), and general decline in bird sightings and calls (20%). These perceptions align with observed ecological stressors in the region.

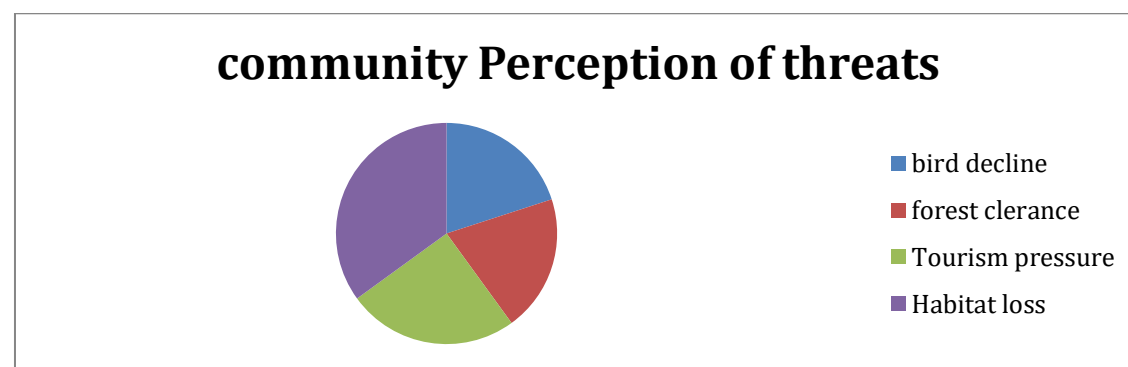


Figure 4. Community Perception of Threats

CONCLUSION

The varied bird species of the Harsh-Jeen hills is influenced by habitat type and elevation. The significance of this environment is demonstrated by the existence of species that are elevation-restricted and conservation-priority. However, there are significant risks due to growing anthropogenic forces. Elevation-specific conservation initiatives that incorporate environmentally friendly tourist regulations and community involvement are required. The study offers baseline data that are essential for long-term arid hill monitoring of biodiversity and policy development.

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