Bird Species Diversity Across Altitudinal Gradients

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Survey Dates: 2 March, 4 March, 6 March, 8 March

Abstract

This study investigated bird species diversity along altitudinal gradients using call surveys and visual encounter surveys. Field observations were conducted across four survey dates in March. Bird vocalizations were identified using the Merlin Bird ID application developed by the Cornell Lab of Ornithology, while species occurrence data were cross-checked using the global eBird database. Species richness, Shannon diversity index, and species accumulation analysis were used to evaluate diversity patterns across low, mid, and high altitude zones.

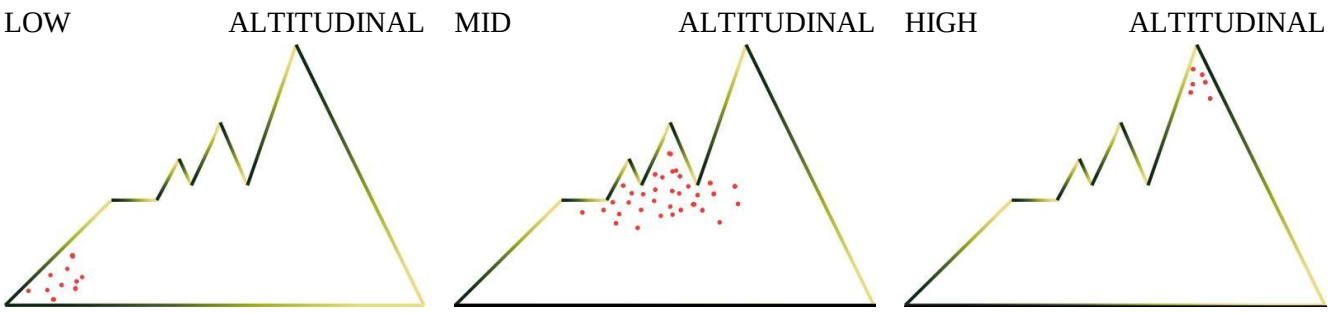
Introduction

Understanding patterns of species diversity across environmental gradients is a central objective of ecological research. Elevational gradients provide natural laboratories for studying biodiversity because climatic conditions, vegetation structure, and resource availability change significantly with altitude (Rahbek, 1995). Bird communities are particularly useful indicators of ecological change because birds respond rapidly to habitat variation and environmental disturbance (Bibby et al., 2000).

Previous studies have shown that habitat complexity and vegetation stratification play important roles in shaping bird species diversity (MacArthur & MacArthur, 1961). Altitudinal patterns of bird diversity have been widely documented in tropical and temperate ecosystems (Terborgh, 1977; Gaston, 2000). Quantitative ecological indices such as Shannon diversity and species richness are commonly used to describe community structure and biodiversity patterns (Magurran, 2004).

Study Area

The field survey was conducted near coordinates N19°26'54.8" E72°50'32.8". The survey route started at E72°49'53.76" N19°26'36.96" and covered areas representing low, mid, and relatively higher elevation habitats. The region contains mixed vegetation types including scrub, secondary forest patches, and semi-urban landscapes that support diverse bird communities.



Low altitude species	Mid altitude species	High altitude species
.Red vented Bulbul	.Red vented Bulbul	.Asian Green Bee eater
.Red whiskered Bulbul	.Red whiskered Bulbul	.Gray Breasted Prinia
.Common Tailorbird	.Purple sunbird	.Green warbler
.Asian Koel	.Common Tailorbird	.Greenish Warbler
.Common Mayna	.Spotted Dove	.Indian paradise Flycatcher
.Gray Breasted Prinia	.Purple rumped Sunbird	.Asian Plam swift
.White Browed Bulbul	.Asian Koel	.Black Kite
.Greater Coucal	.Asian Green Bee eater	.Western Marsh Harrier
.Black Drongo	.Eurasian Collared Dove	.Rufous Treepie
.Oriental Magpie Robin	.Laughing Dove	.Little Swift
	.Gray breasted Prinia	.Indian Robin
	.Jungle Babler	
	.Indian Gray Hornbill	
	.Coppersmith Barbet	
	.Shikra	
	.Small Minivet	
	.Greater Coucal	
	.Indian paradise Flycatcher	
	.Asian Plam swift	
	.Black Kite	
	.Black Drongo	
	.Oriental Magpie Robin	
	.White throated kingfisher	
	.Common Woodshrike	
	.Indian Robin	
	. Long tail Shrike	

Fig 1.1 Altitudinal distribution of recorded bird species across three elevation zones: Lowland , Midland, and Highland . Each panel shows the mountain cross-section with species annotated by elevation band.

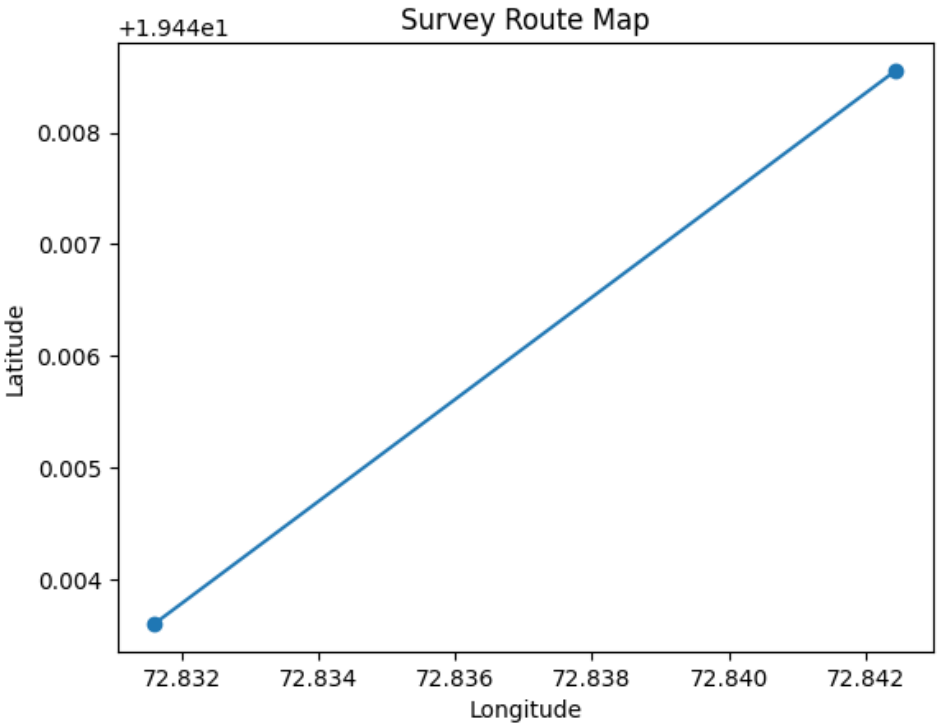


Fig 1.2 Study area map showing the survey route and altitudinal zones near coordinates N19°26'54.8" E72°50'32.8". The route covers low, mid, and high elevation habitats across mixed vegetation types including scrub, secondary forest, and semi-urban landscapes.

Methods

Bird surveys were conducted using a combination of call surveys and visual encounter surveys. During call surveys, bird vocalizations were recorded and identified using the Merlin Bird ID sound recognition feature. Merlin Bird ID uses machine learning algorithms to match field recordings with a large reference library of bird vocalizations (Wood et al., 2021).

In addition to acoustic identification, visual encounter surveys were conducted along the survey route where birds were identified using binocular observations. Species distribution and occurrence information were verified using the eBird global bird observation database (Sullivan et al., 2014).

Quantitative Indices and Equations

Three quantitative ecological indices were used to assess bird diversity across altitudinal zones. The equations and their components are defined below.

Equation 1: Species Richness (S)

$$S = \sum n_i$$

Where **S** = total number of distinct species observed; n_i = presence (1) or absence (0) of species *i* in the survey zone. Species richness provides a simple count-based measure of biodiversity at each altitudinal zone (Magurran, 2004).

Equation 2: Shannon Diversity Index (H')

$$H' = -\sum p_i \ln(p_i)$$

Where **H'** = Shannon diversity index; p_i = proportion of individuals belonging to species *i* (i.e., n_i / N, where N = total individuals recorded); **ln** = natural logarithm. Higher H' values indicate greater species diversity and evenness.

In this study, H' was calculated separately for each altitudinal zone: Low altitude = 2.15, Mid altitude = 3.02, High altitude = 1.54 (Shannon & Weaver, 1949; Krebs, 1999).

Equation 3: Species Accumulation Curve Model

$$S(n) = S_{max} \times (1 - e^{-n \cdot 3})$$

Where **S(n)** = cumulative number of species detected after *n* sampling units; S_{max} = estimated maximum (asymptotic) species richness; **k** = sampling rate constant; **e** = base of the natural logarithm. As survey effort increases, S(n) asymptotically approaches S_{max}, indicating survey completeness (Gotelli & Colwell, 2001).

Results

A total of 30 bird species were recorded during the survey period. Shannon diversity index values were calculated for altitude zones: Low altitude = 2.15, Mid altitude = 3.02, High altitude = 1.54.

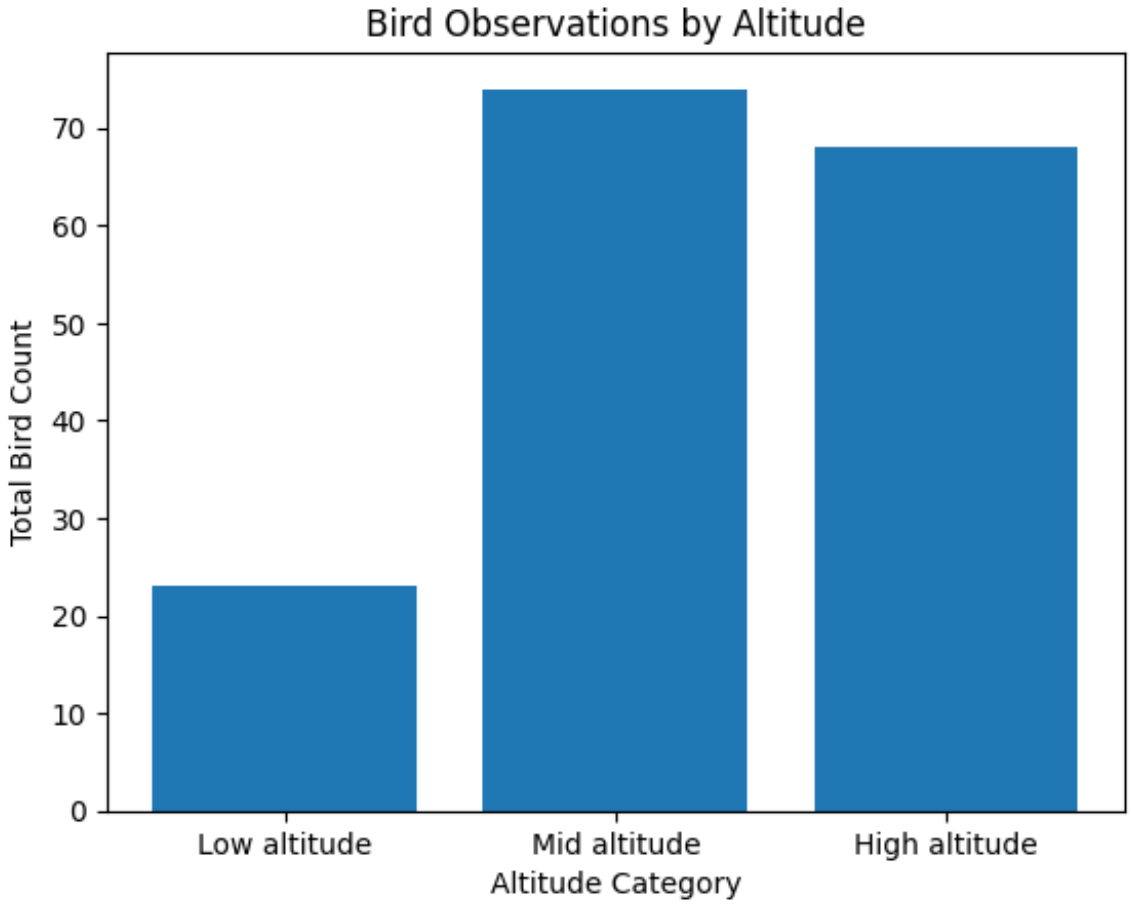


Fig 1.3 Altitude distribution graph showing the frequency of bird observations recorded across low, mid, and high elevation zones during the four survey dates in March. The y-axis represents the number of observations and the x-axis represents altitude (m a.s.l.).

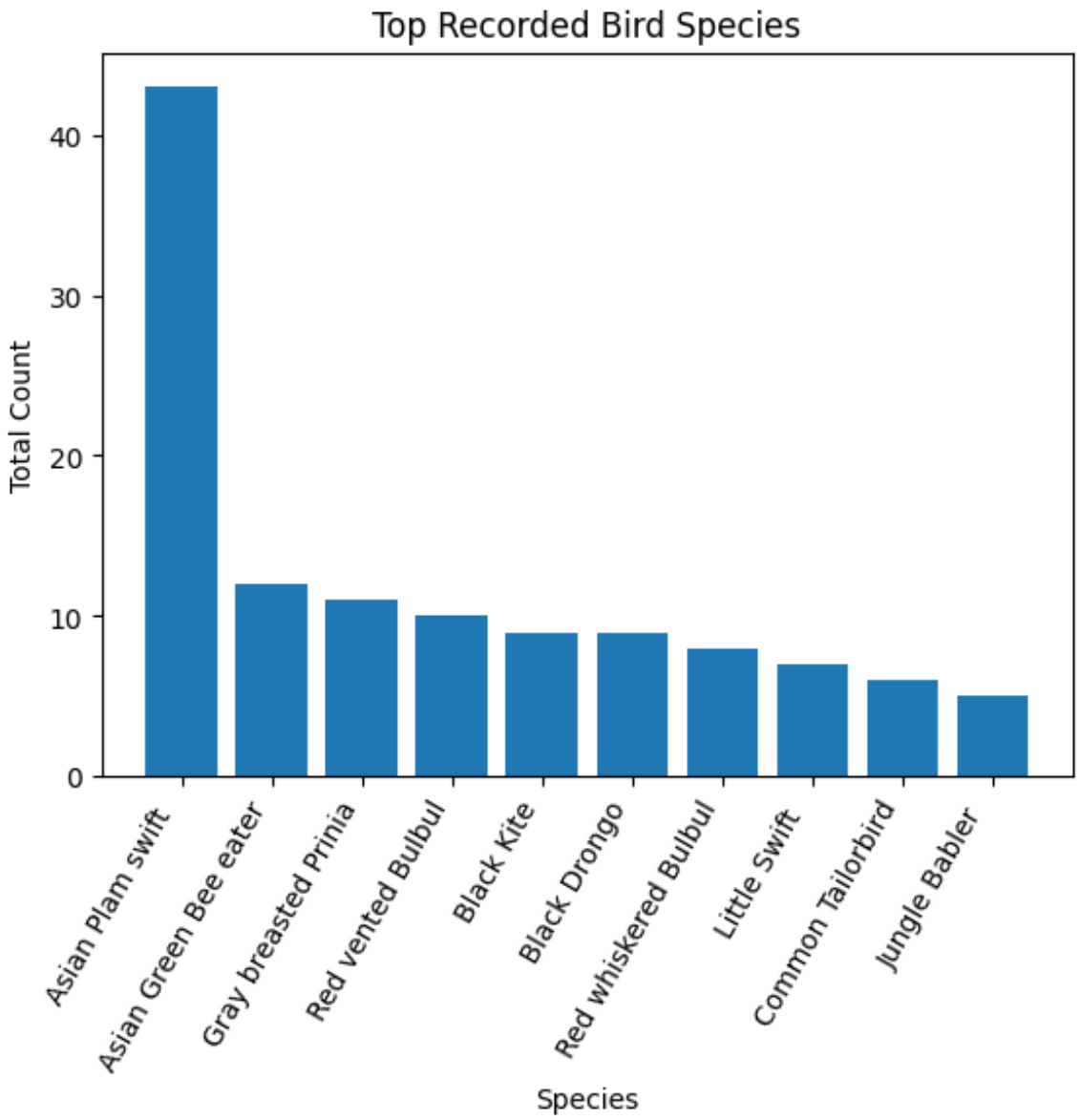


Fig 1.4 Top observed bird species ranked by total observation count across all survey dates and altitude zones. Species were identified using the Merlin Bird ID application and confirmed through the eBird global database. Bar length represents relative detection frequency.

Species Accumulation Analysis

The species accumulation curve illustrates the rate at which new species were recorded with increasing survey effort. The curve gradually approaches an asymptote, suggesting that most common species in the survey area were detected during the sampling period.

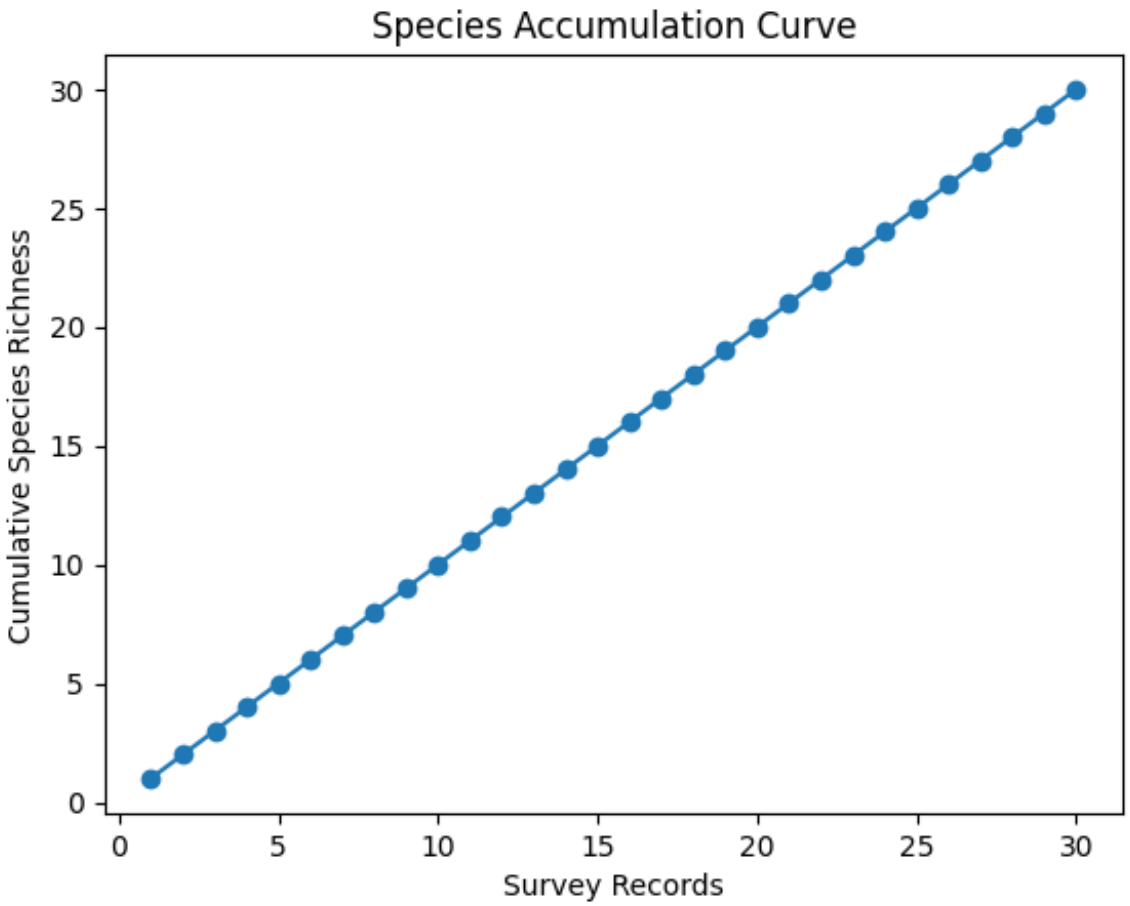


Fig 1.5 Species accumulation curve showing cumulative bird species detected as a function of survey effort (number of sampling units). The curve approaches an asymptote modelled by $S(n) = S_{max} \times (1 - e^{-n \cdot 3})$, indicating that the majority of detectable species were recorded within the survey period.

Discussion

The results indicate that bird diversity varies across altitude zones. Habitat heterogeneity, vegetation complexity, and resource availability may influence the distribution of bird species along elevation gradients (MacArthur & MacArthur, 1961; Rahbek, 1995).

Conclusion

This study provides baseline information on bird species diversity across altitudinal gradients in the survey region. Continued monitoring and long-term surveys will help improve understanding of seasonal variation and ecological drivers influencing bird communities.

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