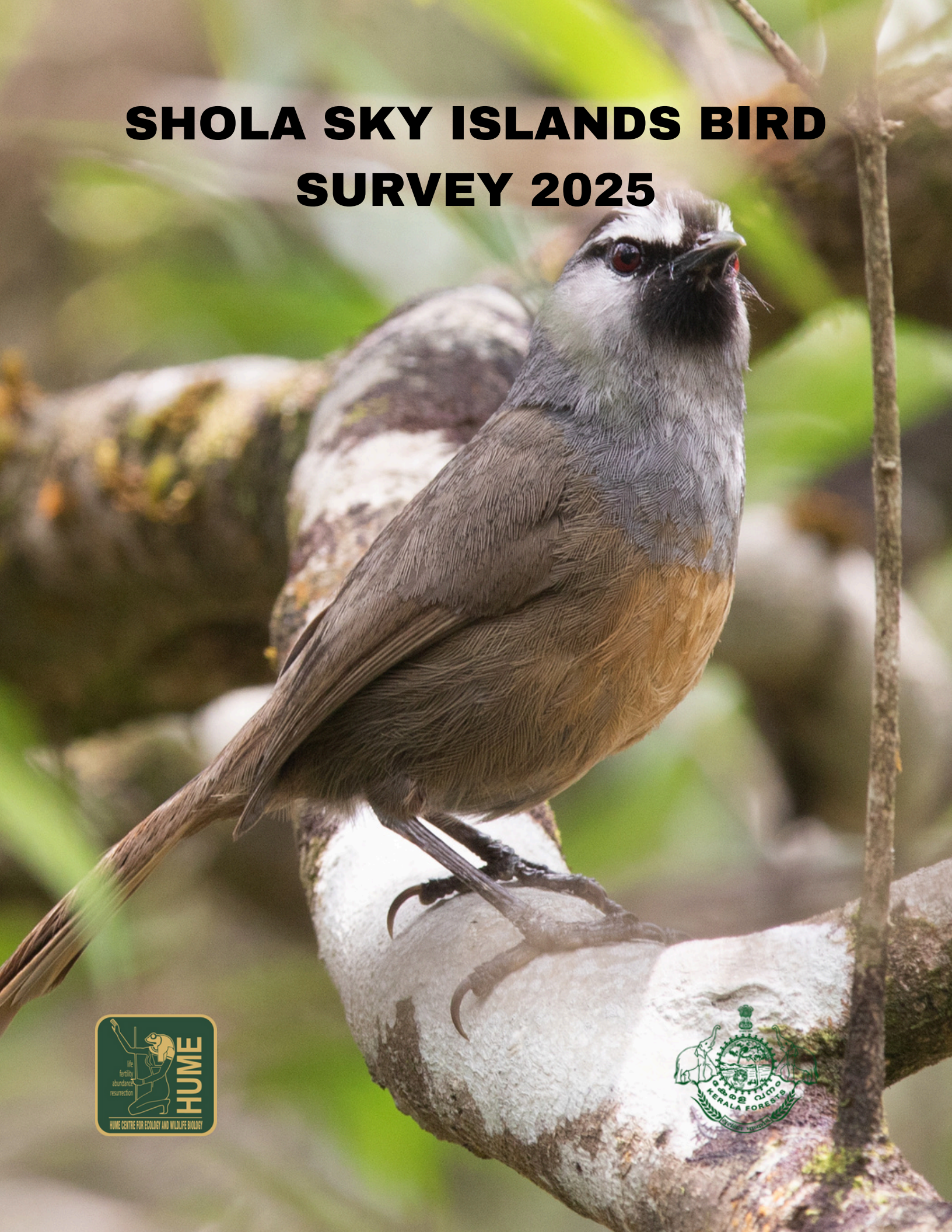
SHOLA SKY ISLANDS BIRD SURVEY 2025



Kerala Forest and Wildlife Department

Organised by:
Hume Centre for Ecology and Wildlife Biology

Wayanad North Forest Division
Wayanad South Forest Division
Aralam Wildlife Sanctuary

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The success of this program would not have been possible without the enthusiastic participation of birdwatchers, the dedication of Forest staff, and the committed efforts of Watchers across the divisions. Their collective involvement and passion for conservation greatly enriched the quality and scope of the survey.

We extend our heartfelt gratitude to all who contributed their time, energy, and expertise to make this initiative truly meaningful and successful.

PREFACE

All life on Earth depends on healthy ecosystems. From clean air and water to food security and climate regulation, ecosystems support both biodiversity and human well-being. However, across the world, ecosystems are increasingly under pressure. The WWF's Living Planet Report 2018 notes that global populations of mammals, birds, fish, reptiles, and amphibians have declined by an average of 60% in just over four decades.In response to these challenges, the United Nations declared 2021–2030 as the Decade of Ecosystem Restoration. This global initiative calls for efforts to protect and revive natural ecosystems to support biodiversity and improve the lives of people who depend on them.

In southern India, the Western Ghats is a globally recognized biodiversity hotspot. It is home to many unique species found nowhere else and plays a crucial role in sustaining the livelihoods of over 40 million people. However, rapid and often unplanned development has led to habitat loss and changes in land use that threaten both wildlife and local communities.

The Hume Centre for Ecology and Wildlife Biology recognizes the urgent need to address these challenges. As part of its long-term vision, the Centre has identified Ecosystem and Wildlife as a key program area for the coming decade. The aim is to support the restoration of degraded ecosystems and the conservation of threatened wildlife in the Western Ghats through practical, science-based approaches.

By combining ecological research with participatory conservation efforts, the Centre hopes to contribute meaningfully to ecosystem recovery and promote coexistence between people and wildlife.

LIMITATIONS OF THE STUDY

The study provides valuable insights into bird diversity patterns across Shola forest patches in Wayanad, while several limitations must be acknowledged. The spatial scale was restricted to select mountain ranges within the district, limiting broader landscape generalizations. Temporal constraints meant that seasonal variations, including migratory movements and breeding patterns, were not fully captured. The analysis focused on relatively intact Shola patches, potentially underrepresenting degraded or transitional habitats. Key ecological factors such as vegetation structure, microhabitat complexity, and anthropogenic disturbance were not quantitatively incorporated. Additionally, detection probabilities were not accounted for, which may influence species richness estimates. The absence of phylogenetic or functional diversity analysis limits deeper ecological interpretation. Methodological constraints such as limited sample size, potential spatial autocorrelation, and the simplification inherent in NMDS ordination also affect the resolution of observed patterns. These limitations highlight the need for broader, multi-seasonal, and multi-scalar approaches in future research.

ABSTRACT

The Shola Sky Islands of the Western Ghats are isolated montane habitats that harbour significant avian diversity and endemism. This study assessed bird species diversity across five mountain ranges in Wayanad, Kerala (Banasura, Brahmagiri, Camels Hump, Kuricharmala, and Manikunnu) situated above 1200 meters. A total of 144 species were recorded, with the Camels Hump range supporting the highest diversity (81 species). Patterns of species richness were found to correspond with mountain area and degree of isolation, consistent with the principles of island biogeography. Birds were classified by taxonomic order and family, with Passeriformes being the most dominant order. Among families, Muscicapidae recorded the highest number of species, followed by Accipitridae and Phylloscopidae. Invertivores constituted the majority of trophic guilds, and species richness showed a general decline with increasing elevation. These findings highlight the importance of habitat area and connectivity in shaping avian communities within sky island ecosystems. They also underline the urgent need for targeted conservation efforts in this ecologically sensitive region, much of which falls under territorial divisions, including reserve and vested forests.

1.INTRODUCTION

The Western Ghats are globally recognised as a crucial biodiversity hotspot. Stretching along India's western coast, roughly 30 to 50 kilometres inland, this mountain range spans the states of Kerala, Tamil Nadu, Karnataka, Goa, Maharashtra, and Gujarat. Covering approximately 140,000 square kilometres over 1,600 kilometres, the Ghats are interrupted only by the 30-kilometre-wide Palghat Gap and the smaller Shencottah Gap (N et al., 2000). Among its most remarkable features is the Shola Sky Islands, a unique ecological phenomenon characterised by high elevation, isolation, diverse microclimates, and significant biodiversity. These montane habitats, ranging between 1,200 and 2,400 meters above sea level, are composed of a mosaic of evergreen forests and grasslands, commonly referred to as the shola-grassland complex.

The concept of island biogeography, first articulated by MacArthur and Wilson, posits that species diversity on islands is shaped by island size and distance from the mainland, influencing immigration and extinction rates (Borregaard et al., 2016). This theory is particularly relevant to the Shola Sky Islands, where geographical isolation has driven high levels of endemism and unique species assemblages (Gupta et al., 2019). The separation of these habitats has fostered distinct evolutionary pathways, leading to the emergence of specialized traits among species, such as unique vocalisations and breeding behaviours adapted to specific habitat conditions (Robin et al., 2017; Purushotham & Robin, 2016). However, the ecological integrity of these sky islands faces growing threats from anthropogenic pressures, particularly the introduction of non-native timber species such as Acacia, Eucalyptus, and Pinus (Jobin et al., 2023). These invasives outcompete native flora and facilitate further invasions, leading to cascading ecological disruptions (Jobin et al., 2022). Over time, the proliferation of plantations has caused significant habitat loss, with tropical montane grasslands reduced by as much as two-thirds in some areas (Arasumani et al., 2018). The resulting habitat fragmentation affects not only plant communities but also animal populations, as

evidenced by studies on butterfly populations showing reduced gene flow and increased genetic structuring in isolated patches (S & P, 2013). Maintaining habitat connectivity thus becomes vital for species survival and ecosystem resilience in the face of environmental changes.

Located at the highest elevations of the Western Ghats, the Shola Sky Islands are particularly vulnerable to the impacts of global warming, further highlighting the urgency for focused conservation efforts (Robin & Nandini, 2012). In this context, the present study, conducted in regions above 1,200 meters above sea level, aims to examine bird diversity and assess variation across mountain ranges, elevation bands, and habitat types. It also explores trophic niches and dominant bird groups within these habitats. Such research is essential for evaluating the conservation status of these highly biodiverse yet under-protected landscapes, which host endangered species like the Banasura Laughingthrush. Effective conservation strategies are needed to ensure the long-term survival of these exceptional ecosystems.

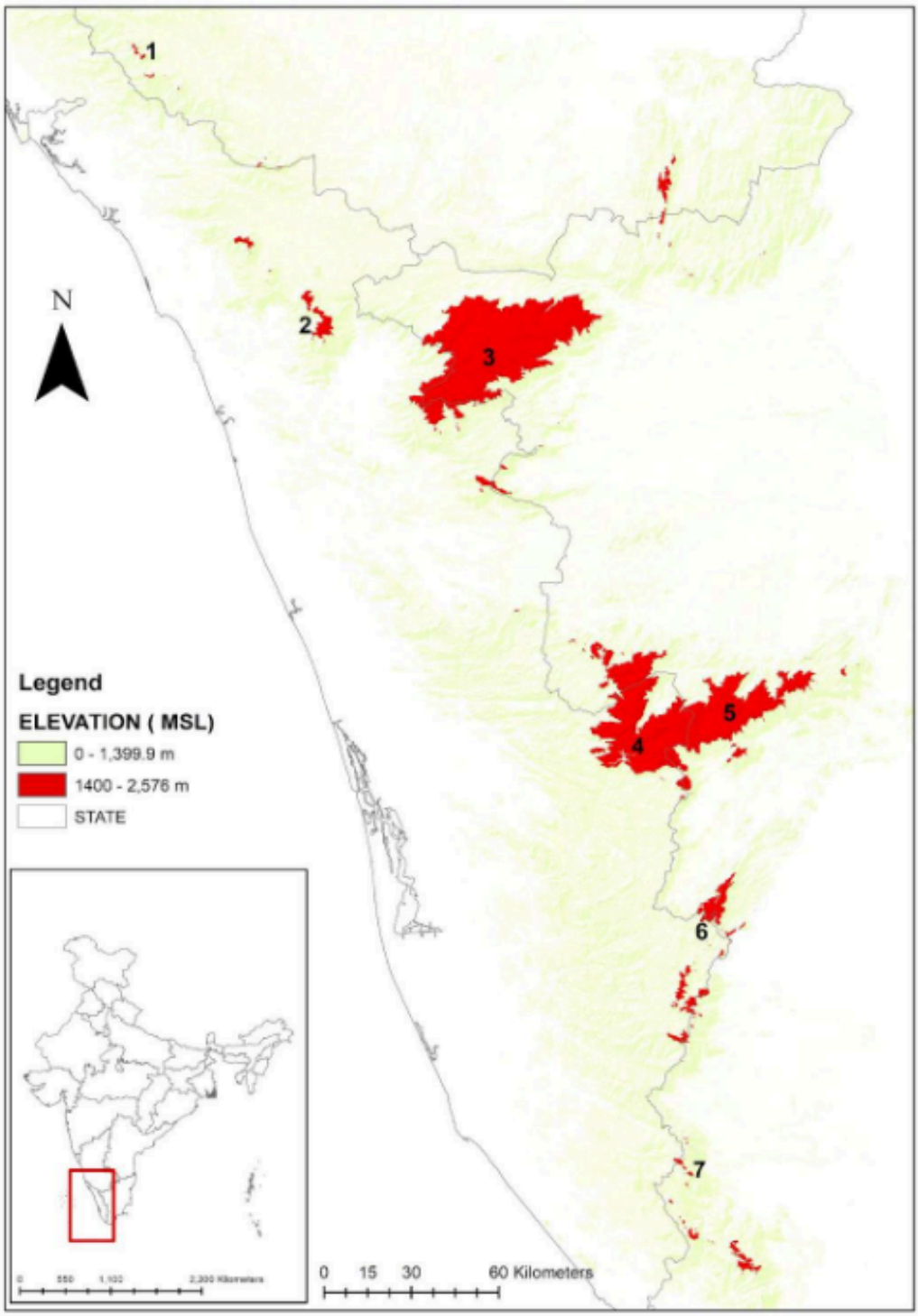
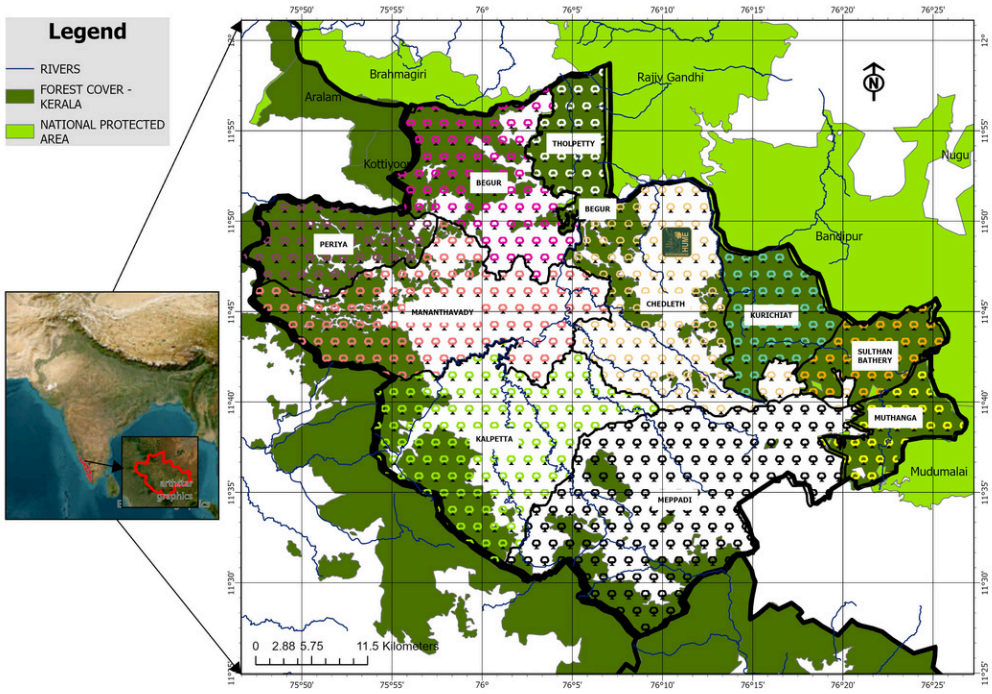


Fig.1.The Shola Sky Islands of the Western Ghats consist of several significant mountain-tops (1 to 7). The northern sky islands include Brahmagiri (1) and Wayanad (2). The Baba Budan Hills, Kudremukh, and Pushpagiri are other mountains from the Northern Sky islands that are not plotted on the map. The highest elevation plateaus form the central sky islands, comprised of the Nilgiri mountains (3) and across the deep Palghat Gap, the Anamalai Hills (4), and Palani Hills (5), which form a single high-elevation plateau. C: The southern sky islands comprise the Meghamalai Hills (6) and the Agasthyamalai or Ashambu Hills (7) mountain range.

2. METHODOLOGY

The study area focuses on Wayanad's mountainous and hilly regions, situated on the western edge of the Western Ghats, spanning elevations between 1,200 and 2,100 meters above mean sea level (msl). It extends from the Brahmagiri ranges in the north to the Camel's Hump mountain in the south. The Camel's Hump Mountains, a distinct east-west aligned range located north of the Nilgiris in the South Wayanad Hills, are recognised as an Important Bird Area (IBA) by BirdLife International, highlighting their ecological significance for avian biodiversity.

Wayanad exhibits a unique climatic profile compared to the lowland plains of Kerala. Temperatures range from 7°C during winter to 33°C in summer, with an average annual rainfall of 3,000 mm. Rainfall distribution varies significantly across the region, ranging from 2,000 mm in the drier northeast to 8,000 mm in the wetter southwest. This climatic diversity profoundly influences the region's vegetation patterns, which include moist deciduous forests in the central and eastern areas, evergreen forests on the slopes of the Brahmagiri mountains, shola grassland complexes in the high-altitude regions, and deciduous forests along the eastern border with Karnataka.Despite a few systematic birding expeditions conducted across the forest divisions of Wayanad in the last decade, limited efforts have been made to explore the region's unique and ecologically significant Shola Sky Islands. The forests in this region are managed by three administrative divisions under the Kerala Forest Department: the Wayanad Wildlife Sanctuary, the South Wayanad Division, and the North Wayanad Division. Biogeographically, the North and South



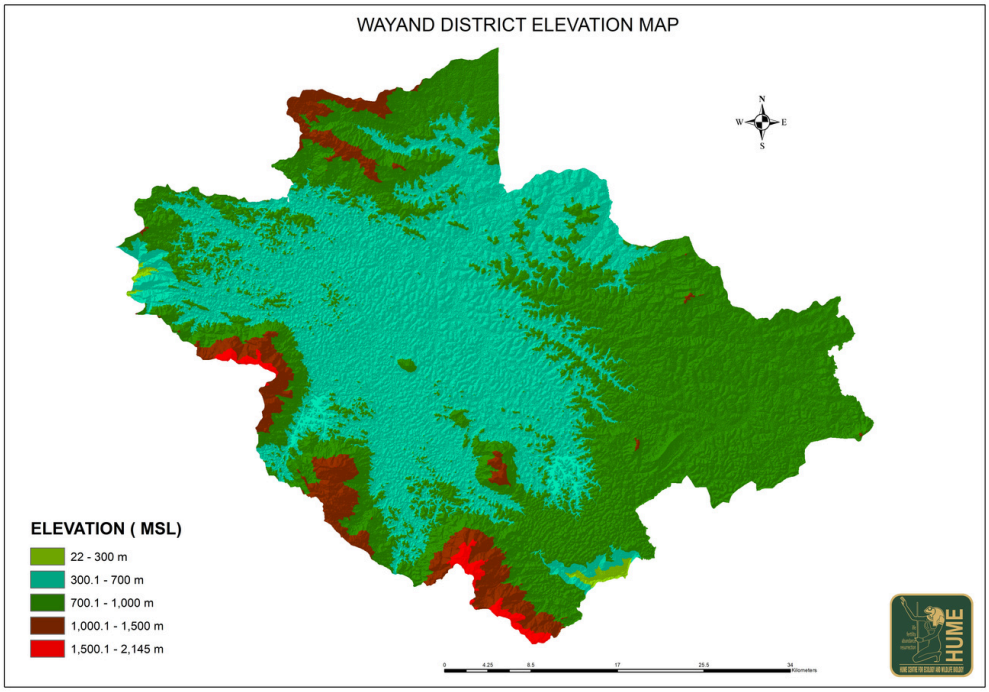


Fig 2 & 3: Top Map: Map showing the study area along with protected areas and forest cover in Wayanad district.
Bottom Map: Elevation map of Wayanad district highlighting different elevation zones from lowlands to highlands.

Wayanad forest divisions are distinct, hosting some of the highest mountain ranges in the Western Ghats, with elevations ranging from 1,200 to 2,100 meters above mean sea level. These areas are characterised by their rich biodiversity, unique vegetation types, and critical ecological functions.

2.2. Study Area and Survey Period

The study was conducted from 18th to 19th January 2025 across five mountain ranges in the Western Ghats of India: Bansura, Camel's Hump, Brahmagiri, Kurichyarmala, and Manikunnu. Surveys focused on two distinct habitat types, Shola evergreen forests and Shola grasslands above 1,200 meters above mean sea level (MSL). Thirteen base stations were established in interior forest areas to facilitate access to pre-defined transects.

2.3. Survey Design and Field Protocol

50 birdwatchers were organised into 15 teams (2–3 members per team). Each team surveyed pre-designated transects (3–10 km long) along established walking paths, reflecting natural terrain rather than linear straight-line routes. Two daily observation sessions were conducted: morning (8:00 AM–12:00 PM) and afternoon (3:00 PM–6:00 PM), adjusted for local light conditions. Each transect required approximately 3 hours, ensuring standardised effort across teams.

2.4. Data Collection

Birds were identified through direct sightings and auditory cues using binoculars (10x50 or 8x40 magnification) and verified with regional field guides. For each observation, the species name, time, number of individuals, and behavioural remarks were recorded. Vegetation structure and land use features (e.g., forest-grassland boundaries) were noted alongside avian data. Data were logged in real-time using the eBird application, generating georeferenced checklists with latitude-longitude coordinates. Only checklists above 1,200 m MSL were retained for analysis.

2.5. Geospatial and Environmental Analysis

Elevation data were extracted from eBird checklists using Arcgis Pro and ArcMap 10.8. Observation points were plotted to visualise the spatial distribution across habitats.

2..6. Quality Control

Teams followed standardised protocols to minimise observer bias, including cross-verification of species identification and adherence to fixed transect timings.All data were cross-checked against eBird's global database for accuracy before analysis.

2.7. Ethical Considerations

Surveys adhered to non-invasive practices, avoiding disturbance to wildlife and habitats. This structured approach ensured robust data collection and integration of field observations with geospatial tools, enabling comprehensive analysis of avian diversity in Shola ecosystems.

2.8. Analysis

2.8.1. Methodology for Spatial Analysis of Shola Landscapes

To analyse the spatial distribution of Shola landscapes, we utilised a Geographic Information System (GIS)-based approach to compute the centroid locations and inter-centroid distances of individual landscape patches. The analysis was conducted using Geopandas, Shapely, and Matplotlib in Python, enabling efficient handling of geospatial data, projection transformations, and visualisation. The analysis began with importing a shapefile representing Shola landscapes. The dataset was loaded using Geopandas, ensuring compatibility with geospatial operations. Since the raw shapefile was in a geographic coordinate system (latitude and longitude), it was reprojected to a projected coordinate system—UTM Zone 43N (EPSG: 32643)—to facilitate accurate distance measurements. This transformation converted angular measurements into metric units, reducing distortions in spatial computations. Centroids for each Shola patch were

calculated using Shapely, which derived the geometric centers of individual polygons. These centroids served as reference points for computing inter-patch distances. A pairwise Euclidean distance matrix was then constructed, where each centroid was compared against all others to determine spatial separation. Distances were measured in meters and converted to kilometres for interpretability. The resulting matrix provided quantitative insights into the spatial dispersion of Shola patches, allowing for assessments of connectivity and isolation within the landscape. To visually interpret spatial relationships, the shapefile was plotted alongside its centroids. The geometries were scaled to kilometres to maintain consistency with distance measurements. Centroids were overlaid as red markers, while inter-centroid distances were illustrated using blue dashed lines. Labels representing individual patches (e.g., mountain names) were extracted from the attribute table and displayed at their respective centroid positions. This visualisation aided in understanding the spatial configuration of Shola patches, highlighting clustering patterns or potential dispersal barriers. This methodological framework provides a robust spatial analysis of the Shola landscape, facilitating further ecological and conservation-oriented studies. By quantifying spatial relationships, this approach supports investigations into habitat fragmentation, connectivity modelling, and landscape-scale biodiversity assessments.

2.8.2. Methodology for Non-Metric Multidimensional Scaling

To analyse species composition across sites, we performed Non-Metric Multidimensional Scaling (NMDS) using Python. NMDS was chosen due to its ability to handle non-normally distributed ecological data and preserve rank-based dissimilarities, making it well-suited for species abundance data.

Data Preparation:

The dataset consisted of bird species counts across the five mountain ranges. The data were loaded and processed using Python's pandas library,

ensuring all values were numeric and handling missing values by replacing them with zeros. The dataset was transposed to compare sites (mountain ranges) rather than species.

2.8.2.1. Bray-Curtis Dissimilarity:

The Bray-Curtis dissimilarity index was chosen for its suitability in ecological studies, as it effectively focuses on relative abundances and handles zero-inflated data. The dissimilarity matrix was computed using the pdist function from the scipy.spatial.distance module, with the Bray-Curtis metric. The resulting matrix was converted into a square form using squareform.

2.8.2.2. Non-metric Multidimensional Scaling (NMDS):

NMDS was selected over other ordination techniques (e.g., PCA or CA) due to its ability to handle non-linear relationships and non-normal data. NMDS was performed using the MDS function from the sklearn. Manifold module, with two dimensions and a precomputed dissimilarity matrix. The stress value, which quantifies the goodness of fit, was calculated as part of the NMDS output.

2.8.2.3. Diversity Indices:

Shannon and Simpson diversity indices were computed for each mountain range to assess species richness and evenness. The Shannon index was calculated using the entropy function from scipy. Stats, while the Simpson index was computed manually using the formula representing each species' proportion.

$$D = \sum_{i-1}^{S} p_i^2$$

2.8.2.4.True Diversity Calculation

Since diversity indices are not directly comparable, we converted them into an effective number of species (True Diversity) using Hill Numbers.

a. **True Diversity from Shannon Index ($^1D = e^{H'}$)**

Shannon diversity is converted into the true number of equally common species:

$$^1D = e^{H'}$$

Where:

e is the base of the natural logarithm (~2.718).

b. **True Diversity from Simpson Index (^2D)**

The Simpson index is transformed into the number of dominant species:

$$^2D = \frac{1}{1 - D}$$

3. RESULTS

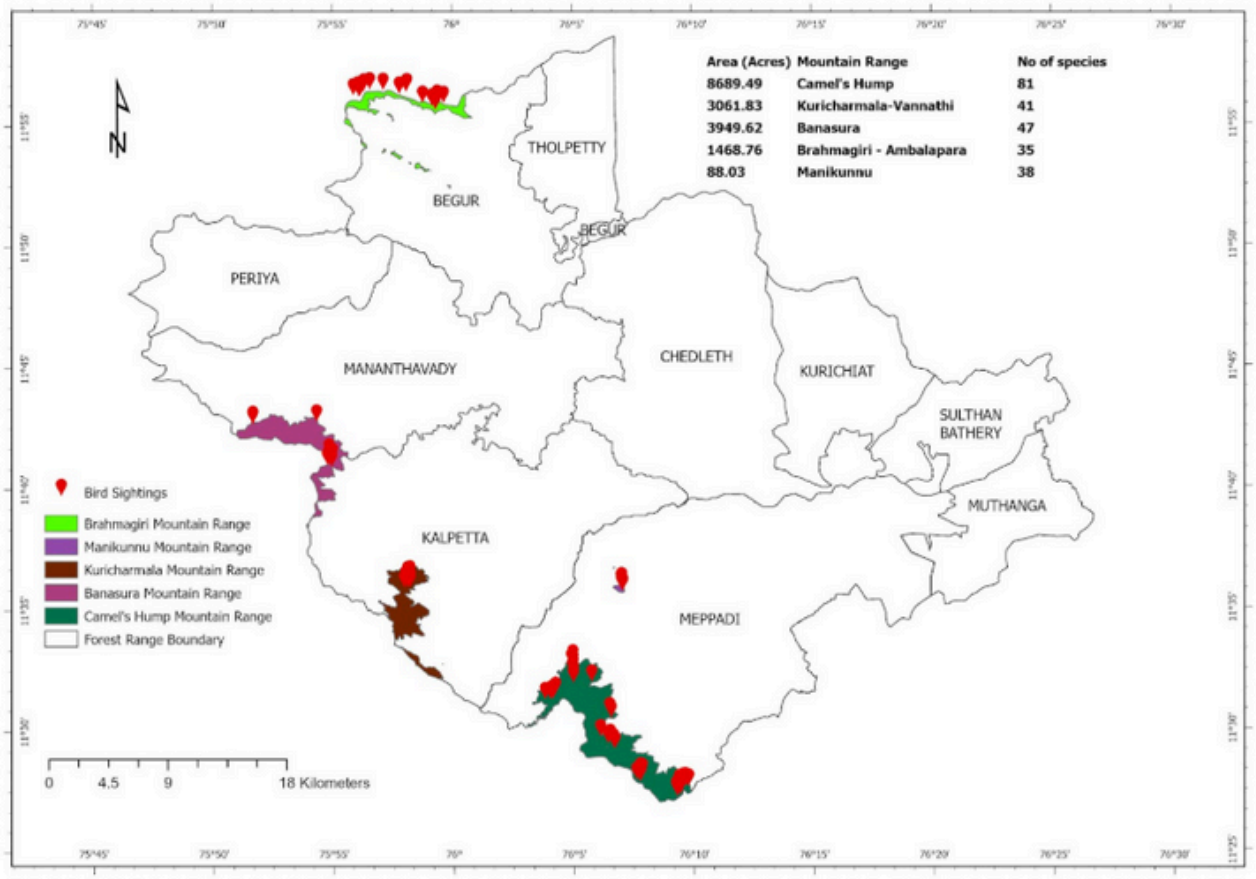
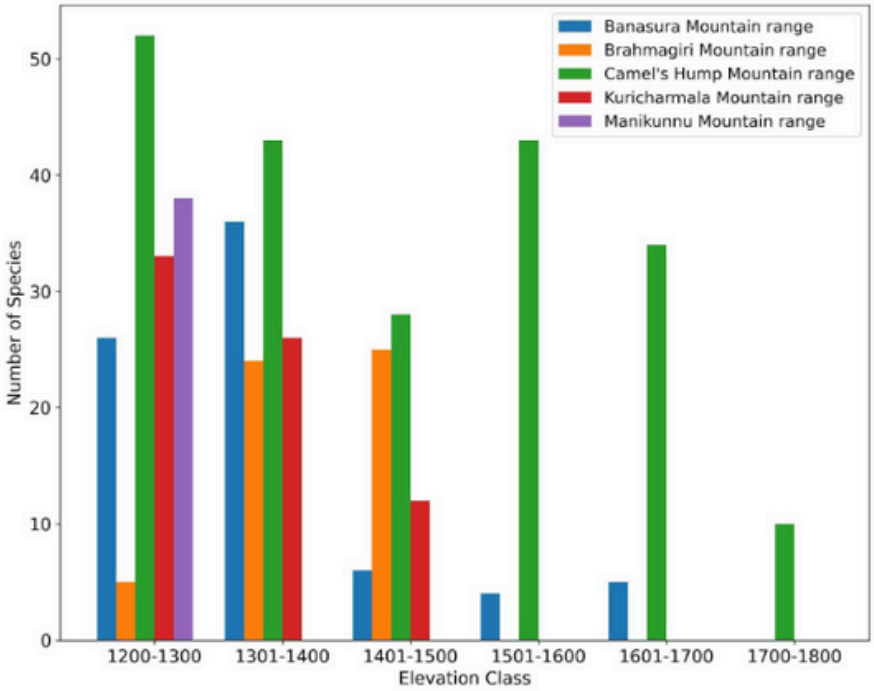


Fig 4: Map showing eBird data points across five mountain ranges where bird surveys were conducted. Each range is color-coded, and red dots represent recorded eBird observations.

The study reported a total of 144 bird species across all altitudes. The Shola forests of the South and North Wayanad regions (Camel's Hump Mountains, Banasura Mountain, Kurichyarmala, Amaba-Vannathi Complex, and Brahmagiri) revealed a remarkable bird diversity of 114 species belonging to 44 families and 13 orders, Within the altitudinal range of 1200–1800 meters, 63 species were recorded from the Shola forests of the North Wayanad Division, and 99 species were recorded from the Shola forests of the South Wayanad Division. The diversity across mountain ranges in the Wayanad region revealed distinct bird species diversity. The Banasura Mountain range recorded 47 species, while the Brahmagiri Mountain range supported 35 species. The Camel's Hump Mountain range, being the most biodiverse among the surveyed ranges, recorded 81 species. The Kuricharmala Mountain range had 41 species, and the Manikunnu Mountain range recorded 38 species.



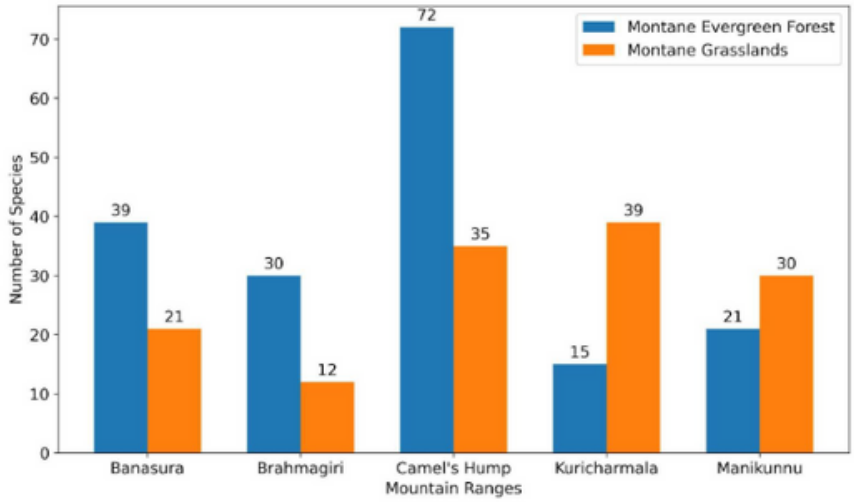
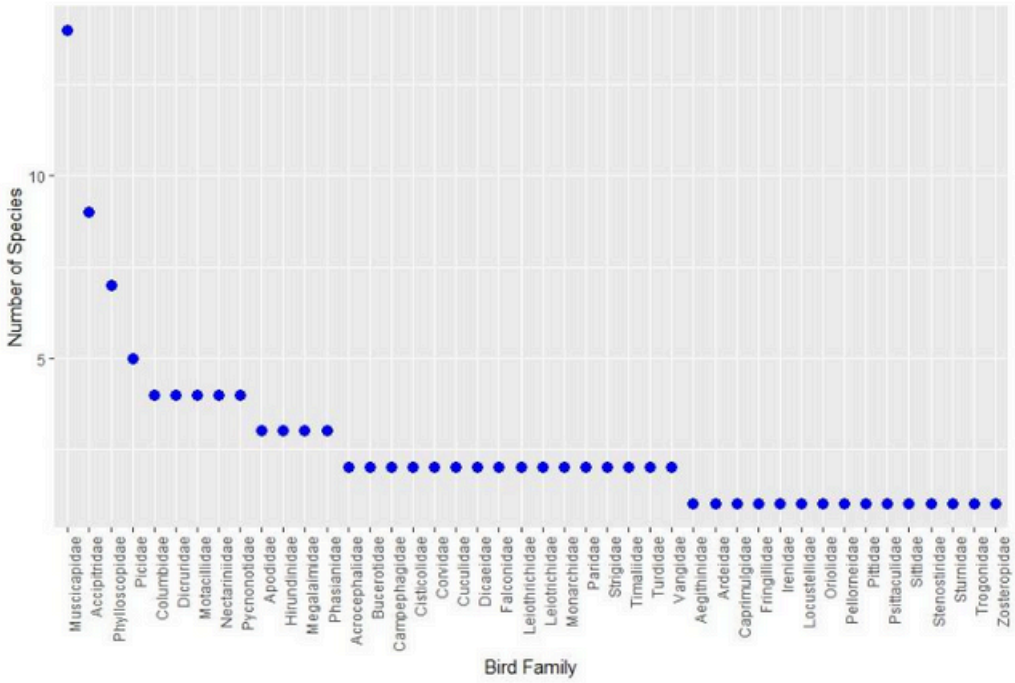


Fig 5 & 6: Top Figure: Species distribution across elevation classes in five mountain ranges. Bottom Figure: Species counts in two vegetation types across the same mountain ranges.

TAXONOMIC DISTRIBUTION OF BIRD SPECIES: ANALYSIS AT FAMILY AND ORDER LEVELS

The analysis of bird species distribution across different taxonomic levels revealed significant variations in species richness among families and orders. Muscicapidae exhibited the highest species count at the family level, followed by Accipitridae and Phylloscopidae, due to seasonal influence as they are migratory indicating their dominance in the observed dataset. Several families, including Campephagidae, Dicruridae, and Paridae, showed moderate species richness, while many others displayed fewer species, highlighting the uneven distribution across families. At the order level, Passeriformes overwhelmingly contained the highest number of species, far surpassing other orders, consistent with its status as the most diverse avian order globally. Other orders, such as Accipitriformes, Piciformes, and Columbiformes, had relatively lower species counts, reinforcing the dominance of passerines in avian biodiversity.



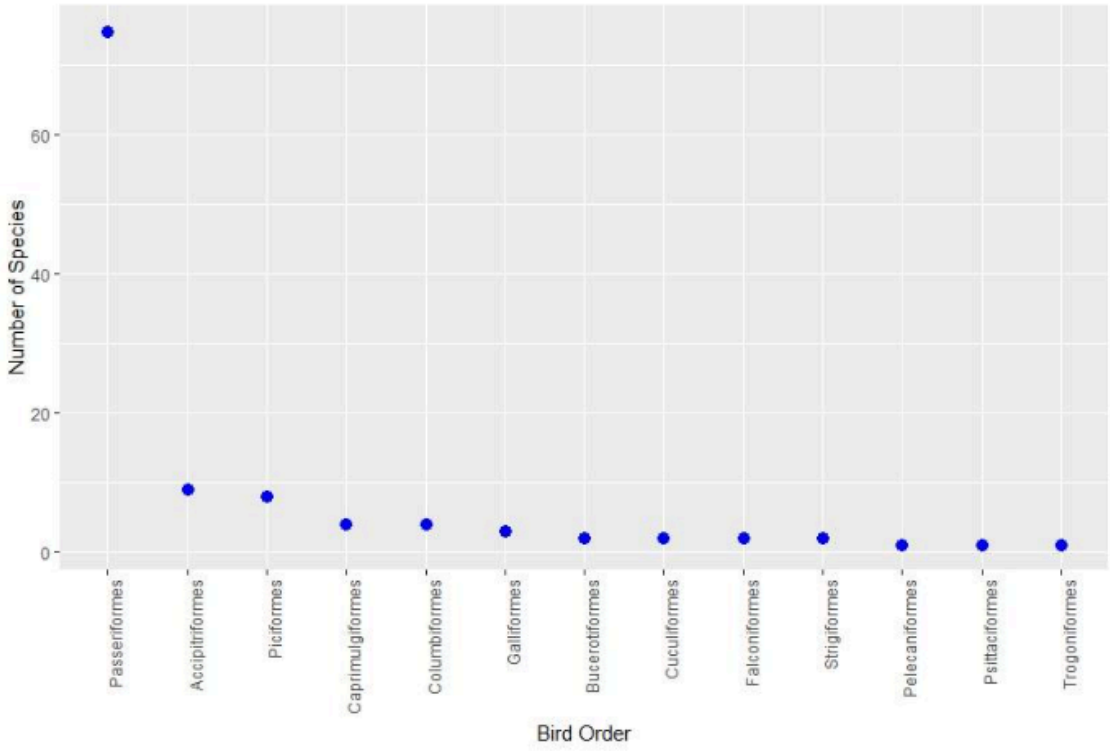


Fig 7 & 8: Top Plot: Bar graph showing the number of bird species recorded across different bird families, with Muscicapidae and Phylloscopidae having the highest counts.
Bottom Plot: Bar graph showing the number of bird species recorded across various bird orders, with Passeriformes being the most species-rich order.

TROPHIC NICHE VARIATION ACROSS MOUNTAIN RANGES

The distribution of trophic niches varies significantly among mountain ranges, with invertivores consistently exhibiting the highest species richness. Camel's Hump Mountain range harbors the most invertivorous species (48), followed by Banasura (27), Kuricharmala (25), Manikunnu (23), and Brahmagiri (18). The dominance of invertivores suggests that insect prey abundance is a key driver of avian diversity in these landscapes. Frugivores and omnivores are also moderately represented, particularly in

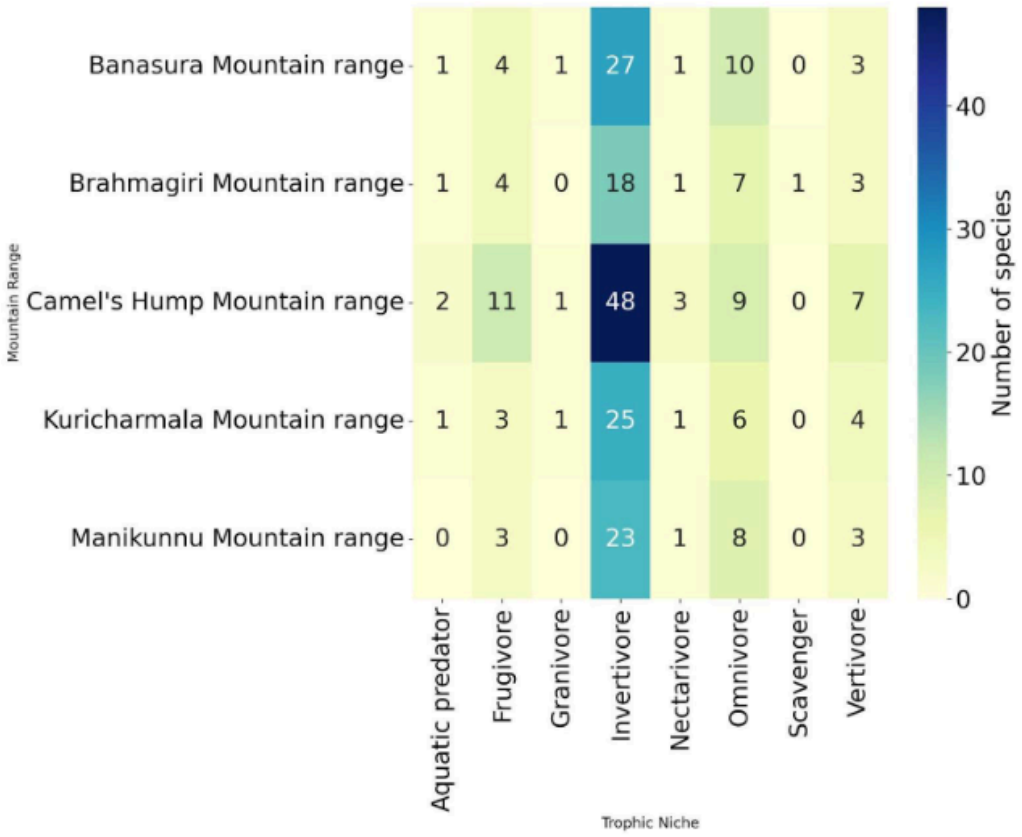


Fig 9. Trophic niche distribution of bird species across five mountain ranges in Wayanad. Insectivores are the most species-rich group in all ranges, particularly in Camel's Hump and Kuricharmala.

Camel's Hump, indicating the importance of fruit resources and dietary flexibility. Conversely, scavengers and vertivores show minimal representation across all mountain ranges, likely due to the limited availability of carrion and vertebrate prey in these montane ecosystems.

The variation in species richness across mountain ranges suggests that habitat heterogeneity and resource availability play critical roles in structuring avian communities. Camel's Hump, which exhibits the highest overall species diversity, may act as a biodiversity hotspot, potentially due to its varied microhabitats, greater vegetational complexity, and intermediate levels of anthropogenic disturbance.

TROPHIC NICHE VARIATION ALONG ELEVATIONAL GRADIENTS

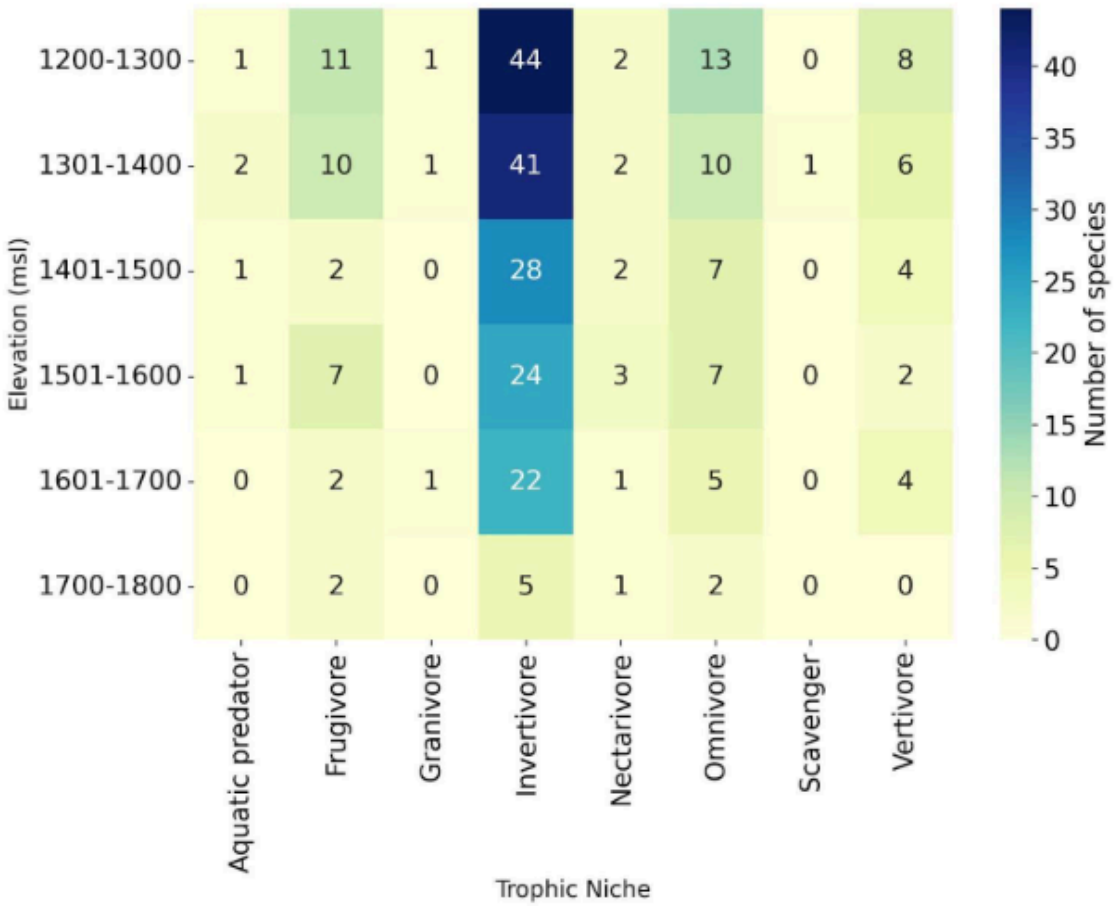


Fig 10. Heatmap showing the distribution of bird species across trophic niches and elevation bands (1200–1800 m) in Wayanad. Insectivores dominate across all elevations, with notable species richness between 1200–1500 m.

A similar pattern emerges when examining species richness across elevational gradients, with invertivores dominating at all altitudes. The highest invertivore richness occurs at lower elevations (44 species at 1200–1300 m and 41 species at 1301–1400 m), followed by a gradual decline with increasing elevation. This trend aligns with the well-documented decline in arthropod abundance at higher elevations, limiting food availability for insectivorous birds. Frugivores, omnivores, and nectarivores also show a decreasing trend with elevation, reflecting shifts in floral and fruiting plant distributions.

The sharp decline in species richness above 1600 m, with only five invertivore species at 1700–1800 m, suggests a threshold effect where climatic conditions, reduced habitat complexity, and limited resources constrain avian diversity. This pattern is consistent with global montane biodiversity trends, where mid-elevation zones often exhibit peak species richness due to an optimal balance of resources and climatic stability.

DIVERSITY INDICES

The diversity indices further supported these findings (Table 2). The Camel's Hump Mountain range exhibited the highest species richness, with 81 species, and the highest Shannon diversity index (3.2278), indicating greater species evenness and diversity. In contrast, the Banasura range had the lowest number of species (47) but maintained a relatively high Shannon diversity (3.0085), suggesting a balanced species distribution despite lower richness. The Simpson diversity index, which measures dominance, was highest for Brahmagiri (0.9313) and Camel's Hump (0.9305), indicating lower dominance and higher evenness in these ranges.

Mountain range	Nearest Neighbor	Mean Isolation Distance	Distance to Nearest Neighbour (KM)	Elevation (meters)	Area (acre)	No. of Species	Shannon Diversity	True Diversity (Shannon)	Simpson Diversity	True Diversity (Simpson)
Banasura Mountain range	Kuricharmala Mountain range	24.9	14.83	2051	3949.62	47	3.0085	20.256992	0.9138	11.600928
Brahmagiri Mountain range	Banasura Mountain range	38.57	26.76	1600	1468.76	35	3.0319	20.736595	0.9313	14.556041
Camel's Hump Mountain range	Manikunnu Mountain range	27.4225	10.78	2100	8689.49	81	3.2278	25.224103	0.9305	14.388489
Kuricharmala Mountain range	Banasura Mountain range	21.655	14.83	1607	3061.83	41	3.0625	21.380943	0.9207	12.61034
Manikunnu Mountain range	Camel's Hump Mountain range	23.2725	10.78	1410	88.03	38	3.0237	20.56725	0.9247	13.280212

Table 1: Summary of ecological and spatial attributes for five mountain ranges in Wayanad, including elevation, forest area, species richness, diversity indices (Shannon, Simpson), and mean pairwise dissimilarity in bird communities.

ISLAND BIOGEOGRAPHY

The study of five sky islands (Banasura, Brahmagiri, Camel's Hump, Kuricharmala, and Manikunnu) in the Western Ghats' Shola ecosystems (≥1,200 m elevation) reveals patterns in biodiversity that align with key principles of island biogeography theory. These montane "islands," isolated by low-elevation valleys, exhibit relationships between area, isolation, and species diversity akin to oceanic islands.

Area-Diversity Relationship

Consistent with MacArthur and Wilson's theory, larger sky islands support higher species richness and diversity. For instance, Camel's Hump, the largest area (8,689.49 acres), hosts the highest species count (81) and Shannon/Simpson diversity indices (True Shannon = 25.22, Simpson = 14.39). In contrast, smaller islands like Manikunnu (88.03 acres) and Brahmagiri (1,468.76 acres) have fewer species (38 and 35, respectively). This reflects the "species-area effect," where larger habitats reduce extinction risks by supporting larger populations and niche heterogeneity. However, exceptions exist: Manikunnu, despite its small size, exhibits moderate diversity (Shannon = 3.02), likely due to its proximity to Camel's Hump (10.78 km), which may act as a species source, mitigating area limitations through dispersal.

Isolation-Diversity Relationship

Isolation metrics (distance to nearest neighbour, mean isolation distance) inversely correlate with species richness. Brahmagiri, the most isolated patch (38.57 km from Banasura), recorded the lowest species richness (35). In contrast, Kuricharmala and Banasura, which are comparatively closer to each other (14.83 km apart), supported higher species richness (41 and 47 species, respectively).

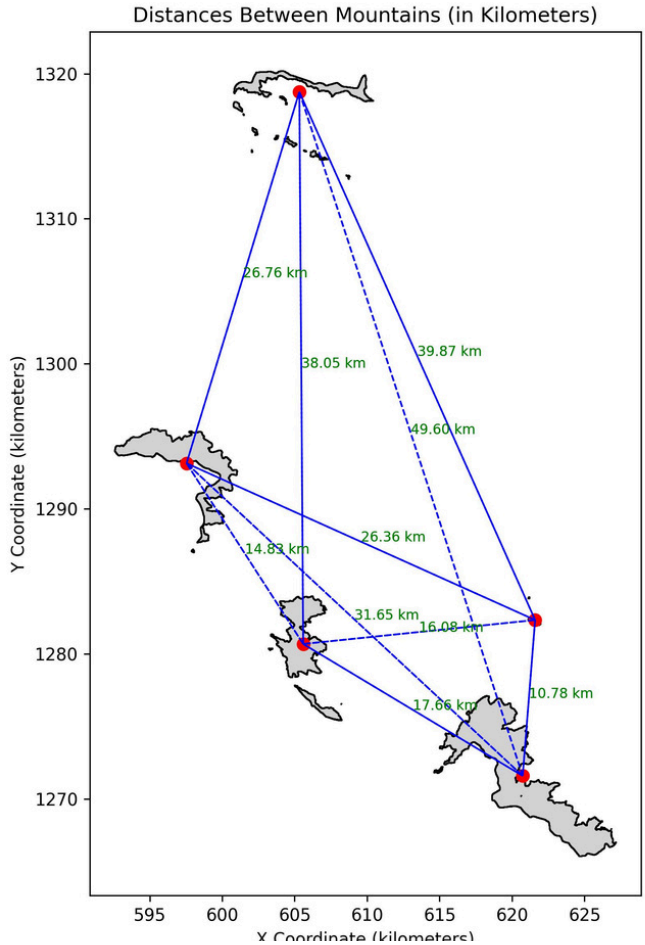


Fig 11: Map showing straight-line distances (km) between mountain ranges in Wayanad, used to assess spatial effects on bird community composition.

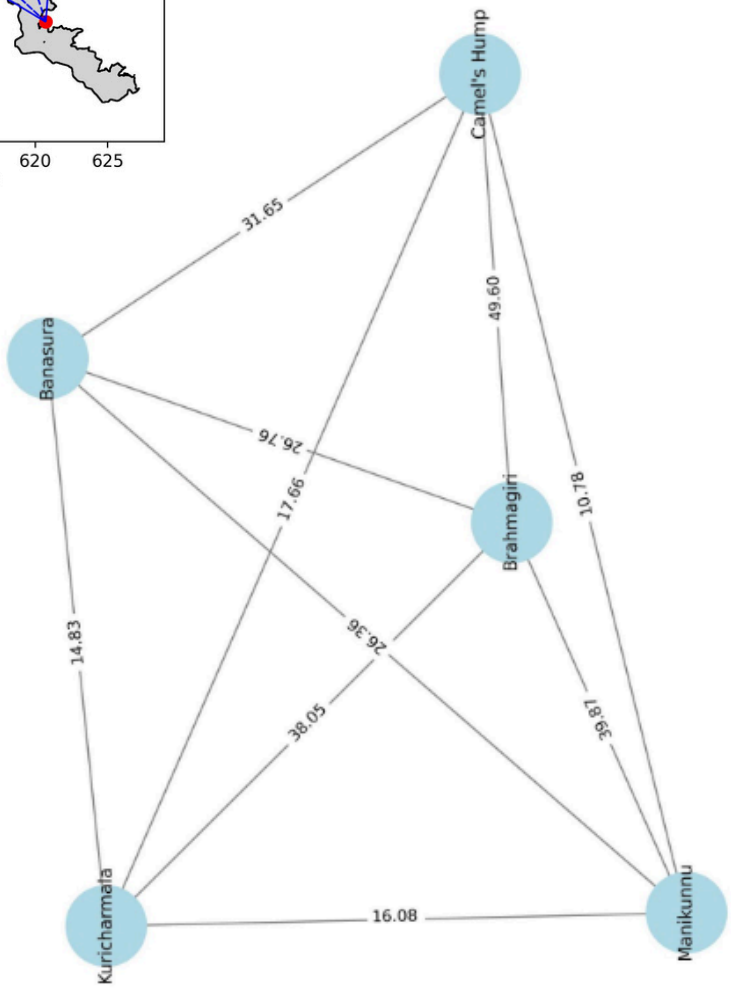


Fig 12: Network diagram illustrating pairwise dissimilarity in bird species composition among mountain ranges in Wayanad. Edge thickness reflects Bray-Curtis dissimilarity values.

These patterns align with the "distance effect," wherein islands closer to source habitats receive higher immigration rates. However, it is important to note that accessibility limitations and temporal factors may have also influenced observed richness. Interestingly, Camel's Hump, despite its moderate isolation (mean distance of 27.42 km), supports high species diversity, likely due to its relatively large area. This underscores the interactive effect of area and isolation, where larger patches may buffer against extinction risks associated with greater isolation.

Habitat Homogeneity and Elevation

All sites share similar Shola habitats, minimising the confounding effects of habitat type. Elevation variations (1,410–2,100 m) may subtly influence microclimates, but the dominant drivers of diversity remain area and isolation. For example, Kuricharmala (1,607 m) and Banasura (2,051 m) differ in elevation but exhibit comparable diversity metrics, suggesting that area and connectivity outweigh elevational effects in this system. Implications for Island Biogeography. These findings reinforce island biogeography principles in sky islands:

- Larger islands act as biodiversity reservoirs, supporting stable populations and diverse niches.
- Proximity reduces isolation, enhancing dispersal and genetic exchange (e.g., Manikunnu's moderate diversity despite small size).
- Extinction risks escalate in small, isolated islands (e.g., Brahmagiri).

However, deviations occur due to unique montane dynamics. For instance, climatic stability in Shola ecosystems may reduce extinction rates compared to oceanic islands, while dispersal barriers (steep valleys) intensify isolation. These nuances suggest sky islands follow biogeographic principles but with context-specific modifiers.

Conservation Insights

Protecting large sky islands (e.g., Camel's Hump) is critical for preserving regional biodiversity. Additionally, maintaining connectivity between proximate islands (e.g., Banasura-Kuricharmala) via habitat corridors could mitigate extinction risks. Smaller, isolated islands like Brahmagiri may require targeted conservation to sustain their unique assemblages. In conclusion, the Western Ghats' sky islands exemplify island biogeography in a montane context, where area and isolation dictate biodiversity patterns. This underscores the universality of MacArthur and Wilson's theory while emphasising the need to adapt its frameworks to account for ecological and topographic complexities in terrestrial "island" systems.

BRAY-CURTIS DISSIMILARITY MATRIX

The analysis of bird species composition across five mountain ranges—Banasura, Brahmagiri, Camel's Hump, Kuricharmala, and Manikunnu—revealed significant differences in community structure and diversity. The Bray-Curtis dissimilarity matrix highlighted the varying degrees of dissimilarity between the mountain ranges (Table 1). The Camel's Hump Mountain range exhibited the highest dissimilarity values compared to other ranges, with values ranging from 0.6928 to 0.7934. In contrast, the Banasura and Brahmagiri ranges showed relatively lower dissimilarity (0.4834), suggesting more similar bird communities between these two ranges

Mountain Range	Banasura	Brahmagiri	Camel's Hump	Kuricharmala	Manikunnu
Banasura	0.0000	0.4834	0.6928	0.5204	0.5574
Brahmagiri	0.4834	0.0000	0.7934	0.5689	0.5182
Camel's Hump	0.6928	0.7934	0.0000	0.7583	0.7664
Kuricharmala	0.5204	0.5689	0.7583	0.0000	0.5803
Manikunnu	0.5574	0.5182	0.7664	0.5803	0.0000

Table 2. Pairwise Bray-Curtis dissimilarity values for bird species composition across five mountain ranges in Wayanad. Higher values indicate greater dissimilarity between ranges. Notably, Camel's Hump shows the highest dissimilarity with all other ranges, while Banasura and Brahmagiri are comparatively more similar.

NON-METRIC MULTIDIMENSIONAL SCALING (NMDS) ORDINATION

The Non-Metric Multidimensional Scaling (NMDS) ordination, with a stress value of 0.1461, provided a robust visualization of the dissimilarity patterns among the mountain ranges (Figure 1). The stress value indicated a good fit, as values below 0.2 are generally considered acceptable in ecological studies. The NMDS plot revealed a clear separation of the Camel's Hump Mountain range from the other ranges, suggesting a distinct bird community structure in this region. In contrast, the Banasura and Brahmagiri ranges clustered more closely, indicating greater similarity in their bird species composition.

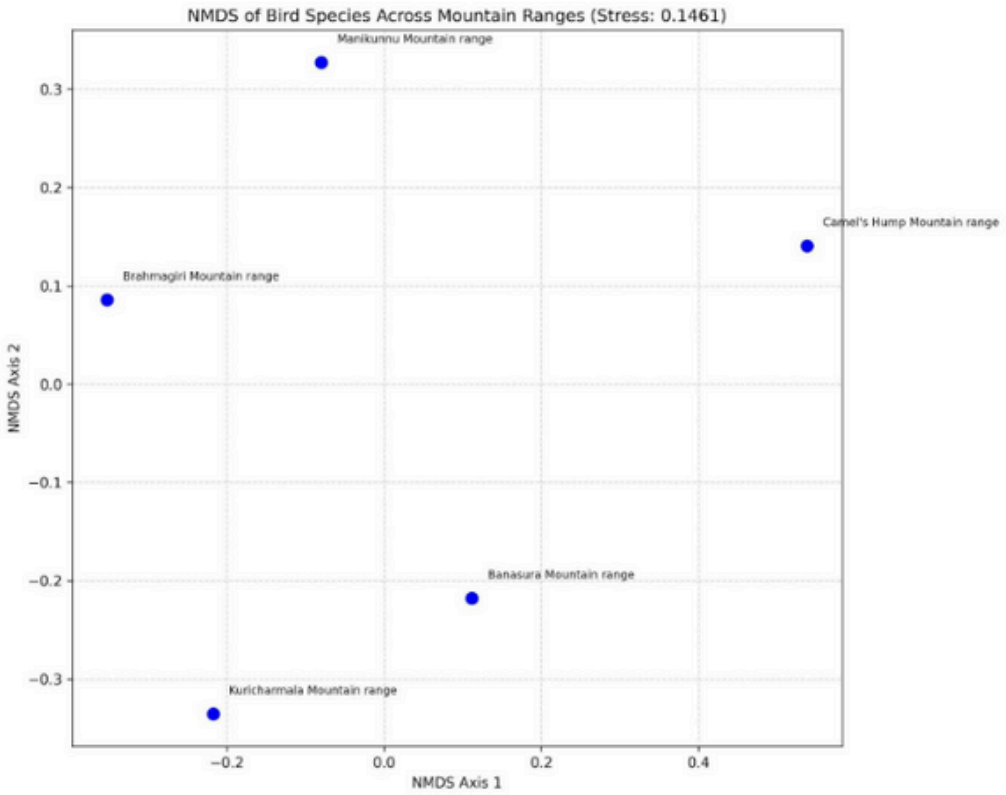


Fig 13. NMDS ordination showing bird species composition across five mountain ranges in Wayanad (Bray-Curtis dissimilarity; Stress = 0.1461). Spatial separation indicates compositional differences among ranges.

APPENDIX A

Summary of Bird Observations Across Elevational Zones

The table in Appendix A presents observational data of bird species recorded across different elevational zones within the study area during the 2022 and 2025 Sky Island Shola Survey. Each entry includes the serial number, local (vernacular) name, scientific name, number of individuals observed, and the elevation range where sightings occurred. This summary serves as a reference for understanding species distribution patterns along the elevational gradient. Below lists the mountain ranges included in the Sky Island Shola Survey and their corresponding codes. These codes are used throughout the dataset and figures to indicate the specific mountain ranges:

- Banasura Mountain range (BM)
- Brahmagiri Mountain range (BA)
- Camel's Hump Mountain range (CH)
- Kuricharmala Mountain range (KM)
- Manikunnu Mountain range (MK)

This coding system ensures clarity and consistency when referencing the ranges in the study.

Order	Family	Scientific Name	Common Name	Mountain Range 2025	Elevation 2025	Mountain Range 2022	Elevation 2022
Accipitriformes	Accipitridae	*Accipiter nisus*	Eurasian Sparrowhawk	BA	1401-1500	BA	1301 - 1400m
Accipitriformes	Accipitridae	*Accipiter virgatus*	Besra	Absent	Absent	KM	1200 - 1300m
Passeriformes	Pycnonotidae	*Acritillas indica*	Yellow-browed Bulbul	BM, BA, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700, 1700-1800	CH, KM, BA, BM	1200 - 1300m, 1301 - 1400m, 1701 - 1800m
Passeriformes	Acrocephalidae	*Acrocephalus agricola*	Paddyfield Warbler	CH	1200-1300	Absent	Absent
Passeriformes	Acrocephalidae	*Acrocephalus dumetorum*	Blyth's Reed Warbler	BM, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700	CH, KM, BA	1200 - 1300m, 1301 - 1400m
Passeriformes	Aegithinidae	*Aegithina tiphia*	Common Iora	CH	1301-1400	Absent	Absent
Caprimulgiformes	Apodidae	*Aerodramus unicolor*	Indian Swiftlet	BM	1301-1400	KM, BA	1301 - 1400m
Passeriformes	Leiothrichidae	*Alcippe poioicephala*	Brown-cheeked Fulvetta	BM, BA, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700	CH, KM	1200 - 1300m, 1301 - 1400m
Passeriformes	Motacillidae	*Anthus hodgsoni*	Olive-backed Pipit	CH, KM	1200-1300, 1601-1700	Absent	Absent
Passeriformes	Motacillidae	*Anthus rufulus*	Paddyfield Pipit	Absent	Absent	CH, KM	1200 - 1300m, 1301 - 1400m
Caprimulgiformes	Apodidae	*Apus affinis*	Indian House Swift	Absent	Absent	CH, KM, BA	1200 - 1300m, 1301 - 1400m
Accipitriformes	Accipitridae	*Aquila fasciata*	Bonelli's Eagle	Absent	Absent	KM	1301 - 1400m
Passeriformes	Nectariniidae	*Arachnothera longirostra*	Little Spiderhunter	CH	1200-1300, 1301-1400, 1401-1500, 1501-1600	BM, CH, KM	1200 - 1300m, 1301 - 1400m
Passeriformes	Leiotrichidae	*Argya subrufa*	Rufous Babbler	BM, KM, MK	1200-1300, 1301-1400	CH, BM	1200 - 1300m, 1301 - 1400m
Passeriformes	Acrocephalidae	*Arundinax aedon*	Thick-billed Warbler	Absent	Absent	KM	1301 - 1400m
Passeriformes	Pycnonotidae	*Brachypodius priocephalus*	Grey-headed Bulbul	Absent	Absent	CH	1200 - 1300m
Bucerotiformes	Bucerotidae	*Buceros bicornis*	Great Hornbill	BA	1301-1400	Absent	Absent
Accipitriformes	Accipitridae	*Buteo buteo*	Common Buzzard	CH	1200-1300	CH, BM	1601 - 1700m, 1701 - 1800m
Caprimulgiformes	Caprimulgidae	*Caprimulgus indicus*	Jungle Nightjar	BM,BA, KM	1200-1300, 1301-1400, 1401-1500	CH	1301 - 1400m

Passeriformes	Fringillidae	*Carpodacus erythrinus*	Common Rosefinch	CH	1200-1300, 1601-1700	Absent	Absent
Cuculiformes	Cuculidae	*Centropus sinensis*	Greater Coucal	CH	1501-1600	CH	1301 - 1400m
Columbiformes	Columbidae	*Chalcophaps indica*	Asian Emerald Dove	BM, CH	1200-1300, 1301-1400, 1501-1600	CH, KM	1200 - 1300m, 1301 - 1400m
Passeriformes	Chloropseidae	*Chloropsis aurifrons*	Golden-fronted Leafbird	Absent	Absent	CH	1200 - 1300m
Piciformes	Picidae	*Chrysocolaptes guttacristatus*	Greater Flameback	Absent	Absent	CH, BA	1200 - 1300m, 1301 - 1400m
Piciformes	Picidae	*Chrysocolaptes socialis*	Malabar Flameback	BA, CH, KM, MK	1200-1300, 1301-1400, 1501-1600, 1601-1700	Absent	Absent
Passeriformes	Nectariniidae	*Cinnyris asiaticus*	Purple Sunbird	Absent	Absent	KM	1301 - 1400m
Passeriformes	Nectariniidae	*Cinnyris lotenius*	Loten's Sunbird	CH	1501-1600	Absent	Absent
Passeriformes	Cisticolidae	*Cisticola exilis*	Golden-headed Cisticola	BM, CH	1200-1300, 1501-1600	CH, KM, BA, BM	1301 - 1400m, 1401 - 1500m, 1601 - 1700m
Accipitriformes	Accipitridae	*Clanga hastata*	Indian Spotted Eagle	Absent	Absent	CH	1200 - 1300m
Columbiformes	Columbidae	*Columba elphinstonii*	Nilgiri Wood-Pigeon	CH	1501-1600	Absent	Absent
Passeriformes	Muscicapidae	*Copsychus saularis*	Oriental Magpie-Robin	BM	1301-1400	CH	1200 - 1300m
Passeriformes	Corvidae	*Corvus macrorhynchos*	Large-billed Crow	BM, CH	1200-1300, 1301-1400	KM	1301 - 1400m
Passeriformes	Stenostiridae	*Culicicapa ceylonensis*	Grey-headed Canary-Flycatcher	BM, BA, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700	CH, KM, BA, BM	1200 - 1300m, 1601 - 1700m, 1701 - 1800m
Passeriformes	Muscicapidae	*Cyornis pallidipes*	White-bellied Blue Flycatcher	KM	1301-1400	CH	1200 - 1300m
Passeriformes	Muscicapidae	*Cyornis tickelliae*	Tickell's Blue Flycatcher	BA, CH, KM, MK	1200-1300, 1301-1400, 1401-1500	CH	1201 - 1300m
Caprimulgiformes	Apodidae	*Cypsiurus balasiensis*	Asian Palm Swift	Absent	Absent	BA	1301 - 1400m
Passeriformes	Corvidae	*Dendrocitta leucogastra*	White-bellied Treepie	BA	1401-1500	CH, KM	1200 - 1300m, 1301 - 1400m
Passeriformes	Motacillidae	*Dendronanthus indicus*	Forest Wagtail	CH	1301-1400	Absent	Absent
Passeriformes	Dicaeidae	*Dicaeum concolor*	Nilgiri Flowerpecker	BM, BA, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700	KM, BA, CH	1200 - 1300m, 1301 - 1400m, 1601 - 1700m

Passeriformes	Dicaeidae	*Dicaeum erythrorhynchos*	Pale-billed Flowerpecker	Absent	Absent	KM	1301 - 1400m
Passeriformes	Dicruridae	*Dicrurus aeneus*	Bronzed Drongo	MK	1200-1300	Absent	Absent
Passeriformes	Dicruridae	*Dicrurus leucophaeus*	Ashy Drongo	CH, KM, MK	1200-1300, 1301-1400	Absent	Absent
Passeriformes	Dicruridae	*Dicrurus macrocercus*	Black Drongo	BA	1301-1400, 1401-1500	Absent	Absent
Passeriformes	Dicruridae	*Dicrurus paradiseus*	Greater Racket-tailed Drongo	CH	1200-1300	Absent	Absent
Piciformes	Picidae	*Dinopium benghalense*	Black-rumped Flameback	CH	1200-1300	Absent	Absent
Columbiformes	Columbidae	*Ducula cuprea*	Malabar Imperial-Pigeon	CH	1200-1300, 1501-1600	KM, BA, CH	1200 - 1300m, 1301 - 1400m, 1401 - 1500m, 1601 - 1700m
Passeriformes	Timaliidae	*Dumetia atriceps*	Dark-fronted Babbler	BA, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600	CH, BA	1200 - 1300m, 1301 - 1400m
Pelecaniformes	Ardeidae	*Egretta garzetta*	Little Egret	CH	1301-1400	Absent	Absent
Accipitriformes	Accipitridae	*Elanus caeruleus*	Black-winged Kite	KM	1301-1400	CH, BM	1301 - 1400m, 1601 - 1700m
Cuculiformes	Cuculidae	*Eudynamys scolopaceus*	Asian Koel	KM	1200-1300, 1301-1400	Absent	Absent
Passeriformes	Muscicapidae	*Eumyias albicaudatus*	Nilgiri Flycatcher	BM, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700, 1700-1800	CH, KM, BA, BM	1200 - 1300m, 1301 - 1400m, 1601 - 1700m
Passeriformes	Muscicapidae	*Eumyias thalassinus*	Verditer Flycatcher	BM, BA, CH	1200-1300, 1301-1400, 1401-1500	Absent	Absent
Falconiformes	Falconidae	*Falco peregrinus peregrinator*	Peregrine Falcon (Shaheen)	CH, MK	1200-1300, 1301-1400, 1401-1500, 1601-1700	KM	1301 - 1400m
Falconiformes	Falconidae	*Falco tinnunculus*	Eurasian Kestrel	CH	1301-1400, 1501-1600, 1601-1700	Absent	Absent
Passeriformes	Muscicapidae	*Ficedula albicilla*	Taiga Flycatcher	BM	1200-1300	Absent	Absent
Passeriformes	Muscicapidae	*Ficedula nigrorufa*	Black-and-orange Flycatcher	BM, BA, CH	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700	CH, BM, KM	1200 - 1300m
Galliformes	Phasianidae	*Galloperdix spadicea*	Red Spurfowl	BM	1200-1300	KM	1301 - 1400m

Galliformes	Phasianidae	*Gallus sonneratii*	Grey Junglefowl	BM, BA, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600	CH, BA, KM, BM	1200 - 1300m, 1301 - 1400m, 1601 - 1700m, 1701 - 1800m
Passeriformes	Turdidae	*Geokichla citrina*	Orange-headed Thrush	CH, MK	1200-1300	CH	1200 - 1300m
Passeriformes	Sturnidae	*Gracula indica*	Southern Hill Myna	CH	1200-1300, 1301-1400	CH, KM	1200 - 1300m, 1301 - 1400m
Accipitriformes	Accipitridae	*Haliastur indus*	Brahminy Kite	Absent	Absent	CH, KM	1200 - 1300m, 1301 - 1400m
Trogoniformes	Trogonidae	*Harpactes fasciatus*	Malabar Trogon	KM	1200-1300	Absent	Absent
Passeriformes	Vangidae	*Hemipus picatus*	Bar-winged Flycatcher-shrike	CH	1501-1600	CH	1200 - 1300m
Accipitriformes	Accipitridae	*Hieraaetus pennatus*	Booted Eagle	BA, CH	1200-1300, 1301-1400, 1601-1700	Absent	Absent
Caprimulgiformes	Apodidae	*Hirundapus giganteus*	Brown-backed Needletail	CH	1501-1600	Absent	Absent
Passeriformes	Hirundinidae	*Hirundo domicola*	Hill Swallow	CH, KM	1301-1400, 1401-1500, 1501-1600	KM	1301 - 1400m
Passeriformes	Hirundinidae	*Hirundo rustica*	Barn Swallow	CH	1200-1300	CH, KM	1200 - 1300m, 1301 - 1400m
Passeriformes	Monarchidae	*Hypothymis azurea*	Black-naped Monarch	MK	1200-1300	CH	1200 - 1300m
Passeriformes	Pycnonotidae	*Hypsipetes ganeesa*	Square-tailed Bulbul	BM, BA, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700, 1700-1800	KM, CH, BA, BM	1200 - 1300m, 1301 - 1400m, 1701 - 1800m
Accipitriformes	Accipitridae	*Ictinaetus malaiensis*	Black Eagle	BM, BA, CH, KM, MK	1200-1300, 1301-1400, 1401-1500	CH, KM, BA	1200 - 1300m, 1301 - 1400m, 1501 - 1600m
Passeriformes	Irenidae	*Irena puella*	Asian Fairy-bluebird	BM, CH	1301-1400, 1501-1600	CH, KM	1301 - 1400m
Strigiformes	Strigidae	*Ketupa zeylonensis*	Brown Fish Owl	Absent	Absent	CH	1200 - 1300m
Passeriformes	Campephagidae	*Lalage melanoptera*	Black-headed Cuckooshrike	CH	1200-1300	Absent	Absent
Passeriformes	Laniidae	*Lanius cristatus*	Brown Shrike	Absent	Absent	CH	1200 - 1300m
Passeriformes	Muscicapidae	*Larvivora brunnea*	Indian Blue Robin	BA, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600	Absent	Absent
Piciformes	Picidae	*Leiopicus mahrattensis*	Yellow-crowned Woodpecker	Absent	Absent	KM	1301 - 1400m

Passeriformes	Nectariniidae	*Leptocoma minima*	Crimson-backed Sunbird	BM, BA, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700, 1700-1800	CH, BM, BA, KM	1200 - 1300m, 1301 - 1400m
Passeriformes	Nectariniidae	*Leptocoma zeylonica*	Purple-rumped Sunbird	BA, MK	1200-1300, 1301-1400	KM	1301 - 1400m
Accipitriformes	Accipitridae	*Lophotriorchis kienerii*	Rufous-bellied Eagle	BM	1200-1300	Absent	Absent
Psittaciformes	Psittaculidae	*Loriculus vernalis*	Vernal Hanging-Parrot	CH	1200-1300, 1301-1400, 1501-1600	KM	1200 - 1300m, 1301 - 1400m
Passeriformes	Paridae	*Machlolophus aplonotus*	Indian Yellow Tit	BM, CH, KM	1200-1300, 1301-1400	KM	1301 - 1400m
Accipitriformes	Accipitridae	*Milvus migrans*	Black Kite	Absent	Absent	CH	1200 - 1300m
Passeriformes	Leiothrichidae	*Montecincla jerdoni*	Banasura Laughingthrush	CH	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700, 1700-1800	CH, KM, BM	1200 - 1300m, 1301 - 1400m, 1501 - 1600m
Passeriformes	Muscicapidae	*Monticola solitarius*	Blue Rock-Thrush	MK	1200-1300	KM	1301 - 1400m
Passeriformes	Motacillidae	*Motacilla cinerea*	Grey Wagtail	BA, CH	1301-1400, 1401-1500, 1501-1600	KM	1301 - 1400m
Passeriformes	Motacillidae	*Motacilla flava*	Western Yellow Wagtail	CH	1200-1300	Absent	Absent
Passeriformes	Muscicapidae	*Muscicapa dauurica*	Asian Brown Flycatcher	CH, MK	1200-1300	Absent	Absent
Passeriformes	Muscicapidae	*Muscicapa muttui*	Brown-breasted Flycatcher	BM, CH, MK	1200-1300, 1301-1400	Absent	Absent
Passeriformes	Muscicapidae	*Myophonus horsfieldii*	Malabar Whistling-Thrush	BM, BA, CH, KM	1200-1300, 1301-1400, 1401-1500, 1501-1600	BM, CH, KM, BA	1200 - 1300m, 1301 - 1400m
Accipitriformes	Accipitridae	*Nisaetus cirrhatus*	Changeable Hawk Eagle	Absent	Absent	KM	1200 - 1300m
Bucerotiformes	Bucerotidae	*Ocyceros griseus*	Malabar Grey Hornbill	BA, MK	1200-1300, 1301-1400	CH	1200 - 1300m
Passeriformes	Oriolidae	*Oriolus kundoo*	Indian Golden Oriole	BM, BA, KM	1200-1300, 1301-1400, 1401-1500	CH	1301 - 1400m
Passeriformes	Oriolidae	*Oriolus xanthornus*	Black-hooded Oriole	Absent	Absent	CH	1301 - 1400m
Passeriformes	Cisticolidae	*Orthotomus sutorius*	Common Tailorbird	Absent	Absent	CH	1301 - 1400m
Passeriformes	Dicaeidae	*Pachyglossa agilis*	Thick-billed Flowerpecker	CH	1301-1400	Absent	Absent

Passeriformes	Paridae	*Parus cinereus*	Cinereous Tit	CH	1401-1500	BM	1200 - 1300m
Passeriformes	Pellorneidae	*Pellorneum ruficeps*	Puff-throated Babbler	BA, CH, MK	1200-1300, 1301-1400, 1501-1600, 1601-1700	CH, KM, BA	1200 - 1300m, 1301 - 1400m
Galliformes	Phasianidae	*Perdicula erythrorhyncha*	Painted Bush-Quail	BM, KM	1301-1400	BM	1401 - 1500m
Passeriformes	Campephagidae	*Pericrocotus flammeus*	Orange Minivet	BM, CH, KM, MK	1200-1300, 1301-1400, 1401-1500	CH, KM	1200 - 1300m, 1301 - 1400m
Accipitriformes	Accipitridae	*Pernis ptilorhynchus*	Oriental Honey-buzzard	CH, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700	KM, CH, BM	1200 - 1300m, 1301 - 1400m, 1501 - 1600m, 1701 - 1800m
Passeriformes	Phylloscopidae	*Phylloscopus affinis*	Tickell's Leaf Warbler	BM, CH	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700	Absent	Absent
Passeriformes	Phylloscopidae	*Phylloscopus humei*	Hume's Warbler	CH	1601-1700	Absent	Absent
Passeriformes	Phylloscopidae	*Phylloscopus magnirostris*	Large-billed Leaf Warbler	BM, BA, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700, 1700-1800	CH, KM, BA	1200 - 1300m, 1301 - 1400m
Passeriformes	Phylloscopidae	*Phylloscopus nitidus*	Green Warbler	BM, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700	CH, KM	1200 - 1300m, 1301 - 1400m, 1401 - 1500m
Passeriformes	Phylloscopidae	*Phylloscopus occipitalis*	Western Crowned Warbler	BM, CH, MK	1200-1300, 1301-1400, 1700-1800	CH	1200 - 1300m
Passeriformes	Phylloscopidae	*Phylloscopus trochiloides*	Greenish Warbler	BM, BA, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700	CH, KM	1200 - 1300m, 1301 - 1400m
Passeriformes	Phylloscopidae	*Phylloscopus tytleri*	Tytler's Leaf Warbler	CH	1601-1700	Absent	Absent
Piciformes	Picidae	*Picumnus innominatus*	Speckled Piculet	CH	1200-1300	Absent	Absent
Piciformes	Picidae	*Picus chlorolophus*	Lesser Yellownape	BM	1301-1400, 1601-1700	CH, KM	1200 - 1300m, 1301 - 1400m
Passeriformes	Pittidae	*Pitta brachyura*	Indian Pitta	KM	1200-1300, 1301-1400	Absent	Absent

Passeriformes	Timaliidae	*Pomatorhinus horsfieldii*	Indian Scimitar-Babbler	BM, BA, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700	KM, BA, CH, BM	1200 - 1300m, 1301 - 1400m, 1401 - 1500m, 1701 - 1800m
Passeriformes	Cisticolidae	*Prinia hodgsonii*	Grey-breasted Prinia	BM, CH	1200-1300, 1301-1400	CH	1301 - 1400m
Piciformes	Megalaimidae	*Psilopogon haemacephalus*	Coppersmith Barbet	BM	1200-1300	Absent	Absent
Piciformes	Megalaimidae	*Psilopogon malabaricus*	Malabar Barbet	CH	1200-1300	KM	1301 - 1400m
Piciformes	Megalaimidae	*Psilopogon viridis*	White-cheeked Barbet	BM, BA, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700, 1700-1800	KM, CH, BA, BM	1200 - 1300m, 1301 - 1400m, 1501 - 1600m
Psittaciformes	Psittaculidae	*Psittacula columboides*	Malabar Parakeet	Absent	Absent	CH	1200 - 1300m
Passeriformes	Leiotrichidae	*Pterorhinus delesserti*	Wayanad Laughingthrush	BA	1401-1500	CH, KM, BA	1200 - 1300m, 1301 - 1400m
Passeriformes	Hirundinidae	*Ptyonoprogne concolor*	Dusky Crag-Martin	KM	1401-1500	CH, KM	1200 - 1300m, 1301 - 1400m
Passeriformes	Pycnonotidae	*Pycnonotus jocosus*	Red-whiskered Bulbul	BM, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700	KM, CH, BM, ,BA	1200 - 1300m, 1301 - 1400m, 1601 - 1700m, 1701 - 1800m
Passeriformes	Pycnonotidae	*Pycnonotus luteolus*	White-browed Bulbul	Absent	Absent	KM	1301 - 1400m
Passeriformes	Pycnonotidae	*Rubigula gularis*	Flame-throated Bulbul	CH	1200-1300	Absent	Absent
Accipitriformes	Accipitridae	*Sarcogyps calvus*	Red-headed Vulture	BA	1301-1400	Absent	Absent
Passeriformes	Muscicapidae	*Saxicola caprata*	Pied Bushchat	CH, KM	1200-1300, 1301-1400, 1401-1500, 1601-1700	CH, KM, BM	1200 - 1300m, 1301 - 1400m, 1401 - 1500m, 1501 - 1600m
Passeriformes	Locustellidae	*Schoenicola platyurus*	Broad-tailed Grassbird	CH	1501-1600, 1601-1700	BM,KM, BA	1301 - 1400m, 1701 - 1800m
Passeriformes	Muscicapidae	*Sholicola major*	Nilgiri Sholakili	CH	1401-1500, 1501-1600, 1601-1700, 1700-1800	CH	1200 - 1300m
Passeriformes	Sittidae	*Sitta frontalis*	Velvet-fronted Nuthatch	BM, CH, KM	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700	CH, KM, BM	1200 - 1300m, 1301 - 1400m, 1701 - 1800m

Accipitriformes	Accipitridae	*Spilornis cheela*	Crested Serpent Eagle	BM, CH, MK	1200-1300, 1301-1400, 1401-1500, 1601-1700	CH, KM, BA,	1200 - 1300m, 1301 - 1400m, 1501 - 1600m
Strigiformes	Strigidae	*Strix leptogrammica*	Brown Wood-Owl	KM	1200-1300	Absent	Absent
Strigiformes	Strigidae	*Strix ocellata*	Mottled Wood-Owl	KM	1200-1300	Absent	Absent
Passeriformes	Vangidae	*Tephrodornis pondicerianus*	Common Woodshrike	BM	1301-1400	Absent	Absent
Passeriformes	Monarchidae	*Terpsiphone paradisi*	Indian Paradise-Flycatcher	BM, BA, MK	1200-1300, 1401-1500	Absent	Absent
Columbiformes	Columbidae	*Treron affinis*	Grey-fronted Green-Pigeon	CH	1200-1300, 1301-1400, 1501-1600	KM	1301 - 1400m
Passeriformes	Turdidae	*Turdus simillimus*	Indian Blackbird	BM, CH	1200-1300, 1301-1400, 1501-1600, 1601-1700	CH	1200 - 1300m
Bucerotiformes	Upupidae	*Upupa epops*	Common Hoopoe	Absent	Absent	KM	1301 - 1400m
Piciformes	Picidae	*Yungipicus nanus*	Brown-capped Pygmy Woodpecker	BM, CH	1301-1400	Absent	Absent
Caprimulgiformes	Apodidae	*Zoonavena sylvatica*	White-rumped Spinetail	BA	1301-1400	Absent	Absent
Passeriformes	Zosteropidae	*Zosterops palpebrosus*	Indian White-eye	BM, BA, CH, KM, MK	1200-1300, 1301-1400, 1401-1500, 1501-1600, 1601-1700, 1700-1800	BM, CH, KM	1200 - 1300m, 1301 - 1400m, 1401 - 1500m, 1601 - 1700m, 1701 - 1800m

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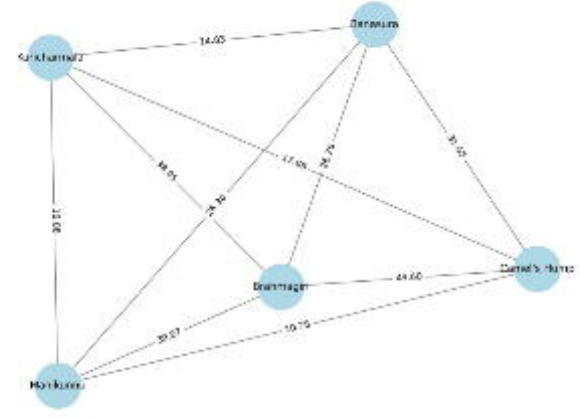
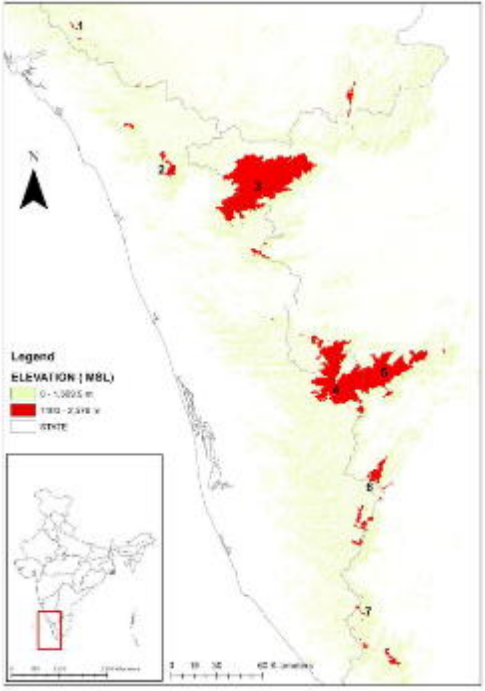
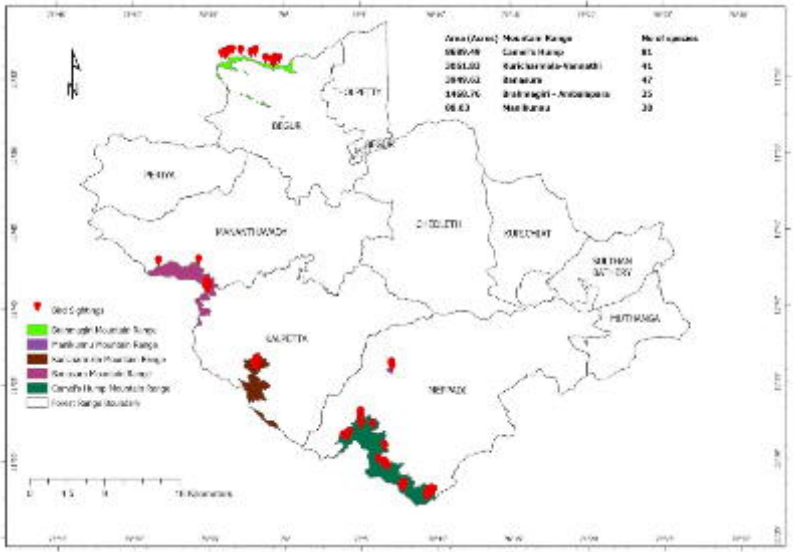
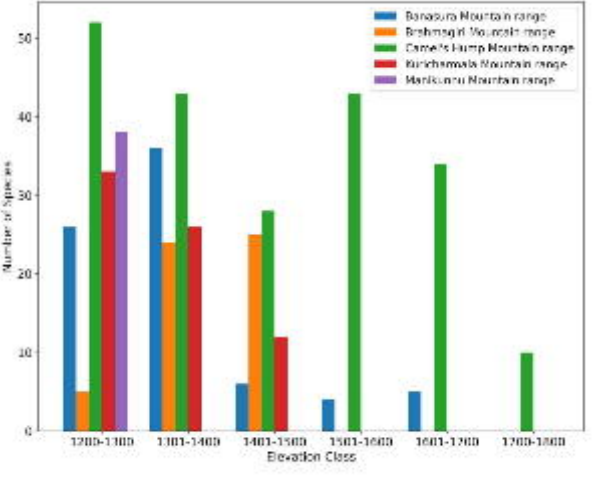
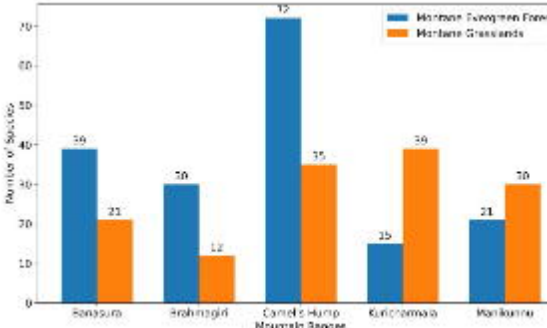



N
Legend
ELEVATION (MSL)
STATE

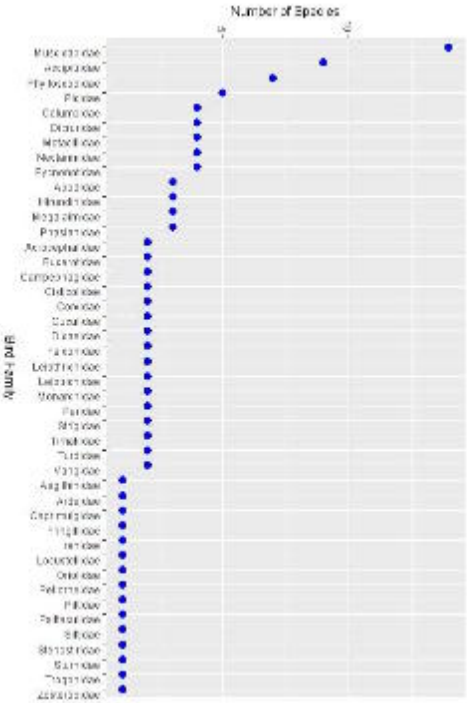


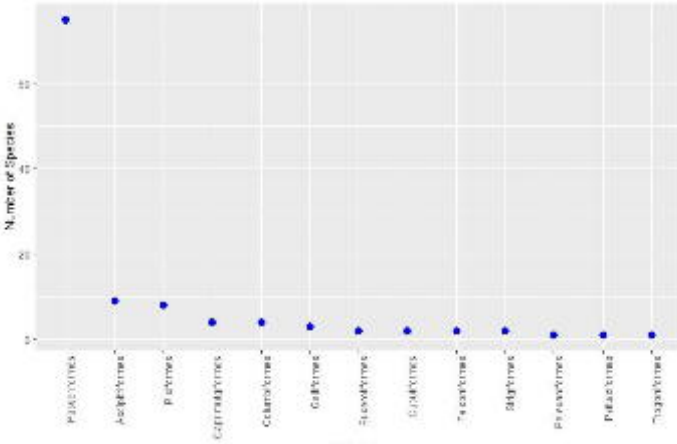
Area (Acres)
Mountain Range
No of species
Camelia Hump
81
Karichamala-Nanaathi
41
Banasura
47
Brahmagiri - Ambalapara
25
Madhunna
30
BEGUR
PERIYA
MAKANTHAMADH
CHEELETH
KURECHIAT
SULTHAN BATHERY
MUTHANGA
KALPETTA
NEIMADE
Bird Sightings
Brahmagiri Mountain Range
Madhunna Mountain Range
Karichamala Mountain Range
Banasura Mountain Range
Camelia Hump Mountain Range
Forest Range Boundary
0
1.5
3
10 Kilometers

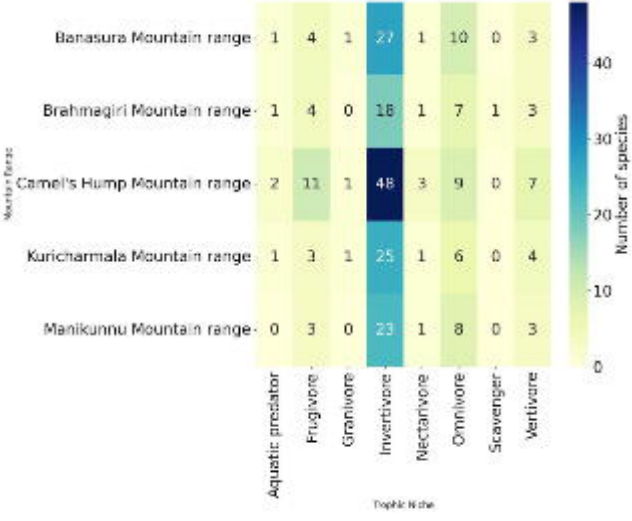

Banasura Mountain range
Brahmagiri Mountain range
Camel's Hump Mountain range
Kurichamala Mountain range
Manikuru Mountain range
Number of Species
0
10
20
30
40
50
1200-1300
1301-1400
1401-1500
1501-1600
1601-1700
1701-1800
Elevation Class

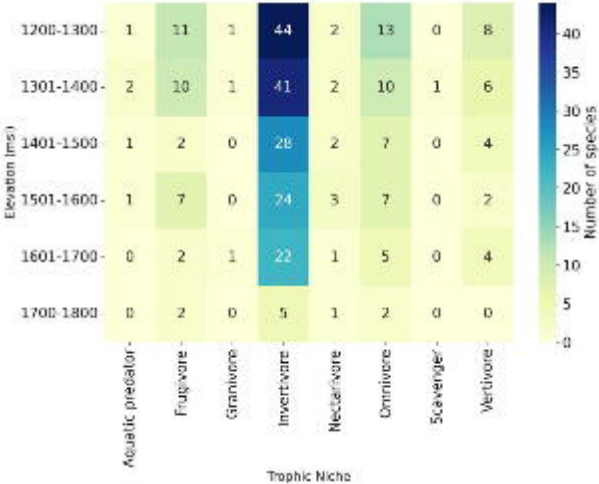

Montane Evergreen Forest
Montane Grasslands
Number of Species
0
10
20
30
40
50
60
70
39
21
30
12
35
15
39
21
30
Banasura
Brahmagiri
Camel's Hump
Kurichermala
Manikunnu
Mountain Ranges

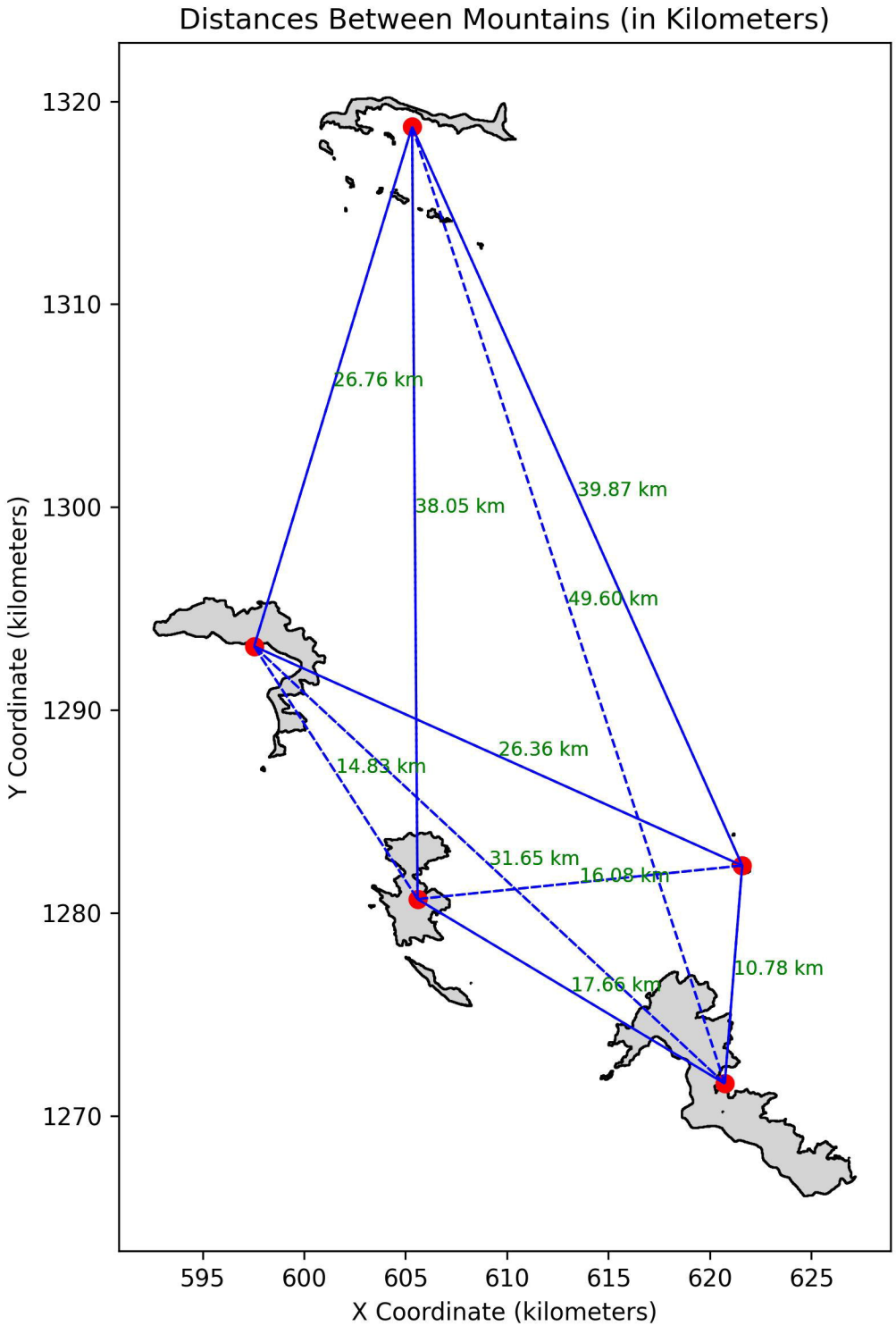
Mountain range	Nearest Neighbor	Mean Isolation Distance	Distance to Nearest Neighbour (KM)	Elevation (meters)	Area (acre)	No. of Species	Shannon Diversity	True Diversity (Shannon)	Simpson Diversity	True Diversity (Simpson)
Banasura Mountain range	Kanchamala Mountain range	24.9	14.83	2064	3948.62	47	3.0000	20.202882	0.9131	11.600928
Bruhmagiri Mountain range	Banasura Mountain range	38.57	26.76	1600	1488.76	35	3.0319	20.738595	0.9313	14.556041
Camel's Hump Mountain range	Mankanna Mountain range	27.4225	10.78	2100	8888.49	81	3.2278	25.224103	0.9305	14.388489
Kanchamala Mountain range	Banasura Mountain range	21.655	14.83	1607	3081.83	41	3.0825	21.380943	0.9207	12.81034
Mankanna Mountain range	Camel's Hump Mountain range	23.2725	10.78	1410	88.03	38	3.0837	20.56725	0.9247	13.280212

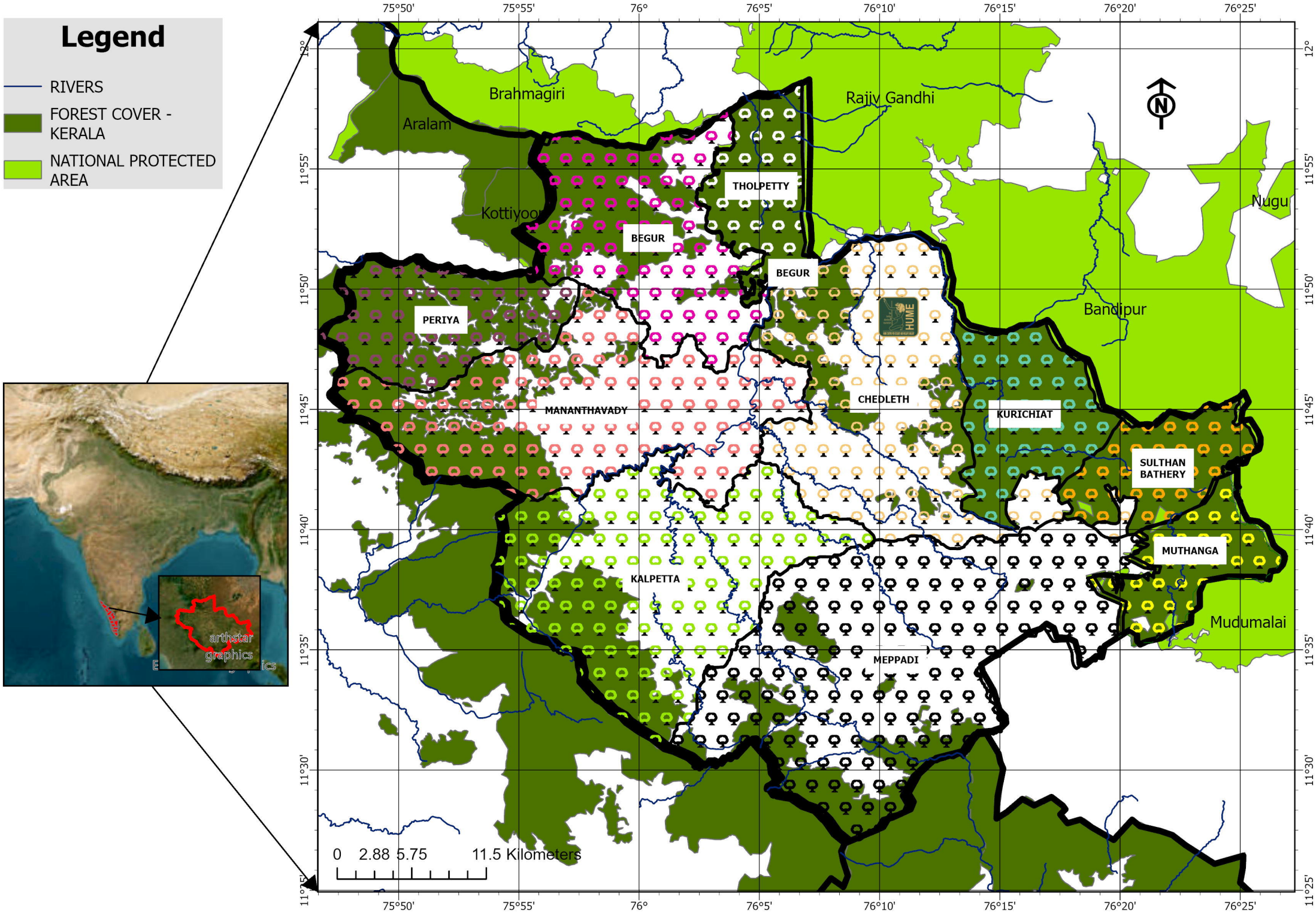

Number of Species
Family name


Number of Species
Bird Order

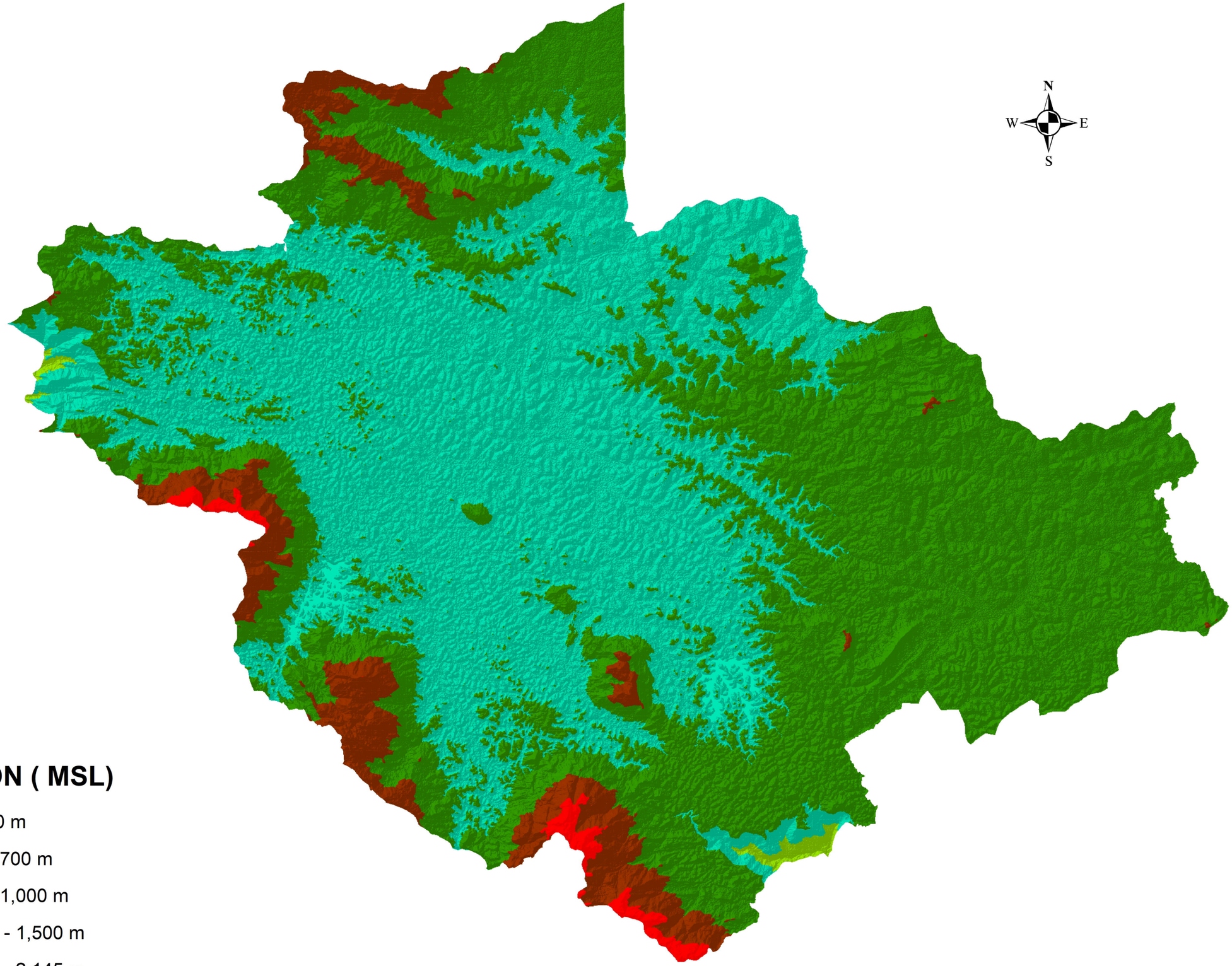

Banasura Mountain range
Brahmagiri Mountain range
Camel's Hump Mountain range
Kuricharmala Mountain range
Manikunnu Mountain range
Aquatic predator
Frugivore
Granivore
Invertivore
Nectarivore
Omnivore
Scavenger
Vertivore
Trophic Niche
Number of species
0
10
20
30
40
1 4 1 27 1 10 0 3
1 4 0 18 1 7 1 3
2 11 1 48 3 9 0 7
1 3 1 25 1 6 0 4
0 3 0 23 1 8 0 3


Elevation (m.s.l)
1200-1300
1301-1400
1401-1500
1501-1600
1601-1700
1700-1800
Aquatic predator
Frugivore
Granivore
Invertivore
Nectarivore
Omnivore
Scavenger
Vertivore
Trophic Niche
Number of species
1 11 1 44 2 13 0 8
2 10 1 41 2 10 1 6
1 2 0 28 2 7 0 4
1 7 0 24 3 7 0 2
0 2 1 22 1 5 0 4
0 2 0 5 1 2 0 0
40
35
30
25
20
15
10
5
0


Distances Between Mountains (in Kilometers)
26.76 km
38.05 km
39.87 km
49.60 km
26.36 km
14.83 km
31.65 km
16.08 km
10.78 km
17.66 km
Y Coordinate (kilometers)
X Coordinate (kilometers)
1320
1310
1300
1290
1280
1270
595
600
605
610
615
620
625


Legend
RIVERS
FOREST COVER - KERALA
NATIONAL PROTECTED AREA
Brahmagiri
Rajiv Gandhi
Aralam
Kottiyoor
Nugu
Bandipur
Mudumalai
THOLPETTY
BEGUR
BEGUR
PERIYA
MANANTHAVADY
CHEDLETH
KURICHIAT
SULTHAN BATHERY
MUTHANGA
KALPETTA
MEPPADI
HUME
N
0 2.88 5.75 11.5 Kilometers
75°50'
75°55'
76°
76°5'
76°10'
76°15'
76°20'
76°25'
12°
11°55'
11°50'
11°45'
11°40'
11°35'
11°30'
11°25'
arthstar graphics

WAYAND DISTRICT ELEVATION MAP



ELEVATION (MSL)

- 22 - 300 m
- 300.1 - 700 m
- 700.1 - 1,000 m
- 1,000.1 - 1,500 m
- 1,500.1 - 2,145 m

0 4.25 8.5 17 25.5 34 Kilometers

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