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POPULATION TRENDS AND ECOLOGICAL DRIVERS OF TEN KEY BIRD SPECIES IN THE SESHACHALAM HILLS, EASTERN GHATS (2024–2025) OF ANDHRA PRADESH IN INDIA

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ABSTRACT

Seshachalam Hills, a part of the Eastern Ghats in the South Indian state of Andhra Pradesh is home to a large variety of bird species. This biodiversity hotspot hosts a large number of endemic as well as habitat-specific species.This study assesses year-to-year population changes of ten ecologically important bird species between the years 2024 and 2025, using field-based population surveys. Habitat characteristics, feeding guilds, nesting behaviour, and habitat-pressure variables (habitat loss, invasive plant cover, quarry disturbance, rainfall anomaly) were analyzed to identify the key drivers affecting the population of these species. Results indicate significant declines in scrub-dependent and moisture-dependent species, especially of the Yellow-throated Bulbul (–25%), Painted Spurfowl (–18.7%), Indian Pitta (–26.7%), and Malabar Whistling Thrush (–27.2%). Correlation analysis shows strong negative associations between population change and habitat loss (r = –0.88), invasive cover (r = –0.83), and quarry disturbance (r = –0.79). Irregularity in rainfall has a strong positive association with the change in the population of species (r = +0.91). The paper points out the need for the conservation of the habitat of bird species, the control of invasive species, the regulation of human activities such as quarrying, and the development of a long-term strategy to conserve the avian diversity in the Seshachalam ranges.

KEYWORDS:

1. INTRODUCTION

The Seshachalam Hills are a part of the southern Eastern Ghats in Andhra Pradesh and are one of India's most ecologically important hill ranges. These hills were designated as the first Biosphere Reserve of Andhra Pradesh in 2010. This entire region has a rugged terrain, several discontinuous hill chains, rocky cliffs, forests that are a tropical dry deciduous type with mixed scrublands, and several small rivulets that support a variety of microhabitats (Rao et al., 2012; Reddy & Umapathy, 2018). This heterogeneous habitat is also home to large number of birds, with over 150 bird species found here. They range from forest specialists, shrub land birds, endemic species, and also several long-distance migrants (Kumar et al., 2020).

One key species of the region is the Yellow-throated Bulbul (Pycnonotus xantholaemus) which is listed as Vulnerable under the IUCN Red List. The bird is a habitat specialist of the rocky hill terrains in this region. Other important species are the White-bellied Treepie (Dendrocitta leucogastra), Indian Pitta (Pitta brachyura), Shaheen Falcon (Falco peregrinus peregrinator). Several woodland raptors also inhabit this region in the dry forest canopies in (Ganesh & Bhaskar, 2017). Scrubland birds are typical of the Eastern Ghats and this important habitat for these birds although several of them are not properly documented in long-term monitoring programs (Sankaran, 2015).

Although rich in flora and fauna, Seshachalamhills are being increasingly exposed to several anthropogenic pressures that continue to change its landscape.Sand extraction from low lying areas, quarrying of granite rock and other rock extraction for industrial purposes continues to change the landscape of rocky hill slopes. This habitat invasion is experienced by species such as the Yellow-throated Bulbul, which is almost entirely reliant on such rock outcrops for nesting as well as temperature regulation (Umapathy et al., 2021). Along with the unregulated growth of such invasive plant species as Lantana camara and Acacia auriculiformis, this has had a significant impact on the natural undergrowth native to the region, thereby impacting the food base for foraging birds, such as certain insectivorous as well as nectarivorous species (Rao & Reddy, 2019).

The region of Tirumala hills, Tirupati and surrounding areas, coming under the Seshachalam range area is also home to one of the most famous temples in the world. This region is also witnessing rapid industrial development and is one of the fastest growing towns in the state. Pilgrimage-driven traffic in Tirumala and surrounding areas, pressure on land and resources due to the large floating population along pilgrim routes contributes to noise, light and sound pollution, and degradation of the forest edge. Rapid urbanisation and industrialisation have also contributed to changes in weather patterns in the region. Conversion of water bodies into urban dwellings, decreased rainfall and tree cover has influenced bird breeding success and seasonal movements in the region (Mahesh et al., 2023). Together, these factors have affected the numbers of the avian community through decline in sensitive species and increases in generalist taxa.

In spite of the rich avian diversity in the region, apart from a few baseline inventories, there is very little systematic year-to-year bird monitoring in Seshachalamhill region. Gaps in fine-scale population change data is a hurdle for forest managers and conservation planners who could otherwise adopt strategies to prevent the population decline at an early stage.It is therefore necessary that short-term comparative surveys across multiple habitat types be conducted so as to provide critical information about species vulnerability, ecological responses to disturbance, and priority areas for habitat protection (Praveen & Nameer, 2022).

This paper details the findings of a research study done in this context. It focuses on the ten ecologically significant bird species of Seshachalam Hills based on their habitat association, feeding and breeding habits, and variation in their population over a period of 2024-2025. Moreover, the research also tends to identify the major factors that are associated with the variation in bird population counts such as habitat disruption, the dispersion of invader vegetation species, and climatic factors.

2. LITERATURE REVIEW

2.1. Avifaunal Diversity of the Eastern Ghats

The Eastern Ghats, although less explored than the Western Ghats, possess diverse avifaunae due to their fragmented topographical features and microhabitats (Rao et al., 2012). Southern Eastern Ghats, especially the Seshachalam-Nallamala hills, are home to over 250 bird species, both habitat -restricted and habitat -specific species as pointed out in several research studies (Kumar et al., 2020). When compared to the Western Ghats and other biodiversity hotspots in India, the Eastern Ghats have not been studied extensively as far as avian diversity and population abundance is concerned (Praveen & Nameer, 2022).

Verry few studies conducted in this region however, have documented the vast diversity of bird population in this region. Reddy and Umapathy (2018) in their study have shown that these dry deciduous forests and scrub-woodland zones are home to a large number of species, due to the habitat

variability. Also several small rivulets in this region and seasonal streams are preferred habitats for insectivorous and fruit-eating birds especially during the post-monsoon season (Ganesh and Bhaskar, 2017).

2.2. Endemic and Threatened Species of the Region

Among the endemic species in the Eastern Ghats, the Yellow-throated Bulbul (Pycnonotus xantholaemus), which is exclusive to Southern India, and listed as 'Vulnerable' in the IUCN list (Praveen et al. 2014), is of great interest to conservationists. This habitat-specialist bird prefers rocky scrub and hill slopes with Euphorbia patches and xerophytic growth. Intensive quarrying in this region and excessive human activity, has in the recent years resulted in significant habitat destruction of the species, leading to a decline in its population, as cited in several studies (Umapathy et al. 2021).

Another notable species is the White-bellied Treepie (Dendrocitta leucogastra), which, although more widely distributed, is a forest-specialized bird that is extremely vulnerable to disturbances in the canopy layer (Sankaran, 2015). Research by Ali & Ripley (1987) among early studies emphasizes how these birds are used as forest quality bioindicators, making their population trends important for conservation status assessments.

2.3. Habitat Disturbance and Land-use Change Impacts

Several studies have identified habitat loss, fragmentation, and degradation to be major factors responsible for the decline of habitat-specialist birds in the Eastern Ghats. Quarrying, and expansion of human activity due to urbanisation and pilgrimage tourism have transformed the continuous forests into fragmented patches of greenery. These changes have had a significant impact on birds that nest on the ground and in the cliffs in these hillocks.

Certain invasive species, such as Lantana camara and Acacia auriculiformis, are also major drivers of change in habitat structure of birds in the region. In most dry deciduous ecosystems, such as that of the Seshachalam hills, it is found that suggests Lantana impacts the diversity of forest undergrowth, thereby altering the population of insects, and therefore affecting the food availability for insectivorous birds (Negi et al., 2018). Studies from the Nallamala Hills show that invasive plant cover correlates negatively with the abundance of several woodland birds (Harikrishna et al., 2021).

2.4. Effects of Climate Variability on Avifauna

Climate variability has also been found to be an important variable affecting bird population dynamics in tropical and subtropical biomes around the world. Results from research conducted in Eastern Ghats indicate reduced pre-monsoon rainfall patterns and prolonged drier periods, resulting in conditions of reduced water availability and breeding delays (Mahesh et al., 2023). Climate change factors in tropical biomes would therefore impact breeding success for biologically specialized bird species, including frugivorous and nectar-feeding birds (Sundar & Kittur, 2013).

Most of migratory species of birds are more vulnerable to change in rainfall patterns. According to Kumar et al. (2020), several post-monsoonal migrants in Andhra Pradesh exhibited irregular migration patterns, especially a delay in their arrival in the region, which might be correlated to rainfall deficit and decline in waters sources in the region.

2.5. Short-term Population Monitoring in India

Short-term, year-wise bird population assessment is rare in India, but it can provide important insights into how local disturbances can impact the ecology of the region. Studies in the Eastern and Western Ghats suggest that even a year's difference can reveal strong responses to habitat changes, particularly in species with narrow ecological niches (Praveen & Nameer, 2022).

Point count–based monitoring has been widely used to assess abundance trends in semi-arid and dry deciduous ecosystems due to its reliability and ease of replication (Bibby et al., 2000). Research in India shows that consistent methods, such as fixed-radius counts and repeated seasonal surveys help in the early detection of population fluctuations caused by human disturbance, climate changes, or availability of food (Ganesh & Bhaskar, 2017).

These results reveal the importance of conducting population comparisons in a short-term population study, especially in Seshachalam Hills with its dynamic environment, wherethe slightest of environmental changes may impact the population of vulnerable species.

2.6. Knowledge Gaps and Need for the Present Study

Though species inventories and distributional data is available for most species, there are significant gaps in understanding the dynamics in the annual population, abundance of species in certain habitats, and the type of ecology that supports breeding of birds in the Seshachalam region. Most of the existing studies focus on broad checklists and general observations, with very less focus on quantitative assessments (Reddy & Umapathy, 2018).

Studies have noticed gaps in:

- Fine-scale temporal abundance comparisons,

- Species-specific feeding and nesting behavioural data,
- Analysis of drivers of short-term declines, and
- Statistical correlation of population trends with disturbance indicators.

Addressing these gaps is essential for developing evidence-based conservation strategies, especially in a rapidly changing ecological context marked by quarrying, invasive expansion, pilgrimage pressure, and climatic stress.

This paper presents the finding of a study that seeks to bridge this research gap by carrying out a comparative evaluation of the ten biologically significant bird species within the Seshachalam Hills during the year 2024 and 2025. The proposed study combines habitat surveys, behavioural recording, and statistical population evaluation.

3. OBJECTIVES OF THE STUDY

1. To estimate and compare populations of 10 ecologically significant bird species in 2024 and 2025.
2. To document the habitat, feeding, and nesting behaviour of each species.
3. To analyze correlations between population changes and habitat-pressure variables.
4. To identify primary drivers of observed declines and recommend conservation strategies.

4. METHODOLOGY

4.1. Study Area

The Seshachalam Hill Range in the Eastern Ghats of Andhra Pradesh was chosen as the study area.These hills cover an area of 4,755 sq. km and include tropical dry deciduous, scrub, rocky, riparian, and mosaic ecosystems. Major sites that formed a part of the study are: Tirumala Reserve, Talakona Wildlife Sanctuary Zone, Mamandur and Kapilatheertham area and Seshachalam Biosphere Reserve Core and Buffer Zones. These are the main habitat gradients of endemic birds of this region.

4.2. Selection of Focal Bird Species

Bird species in the study were chosen based on their ecological importance and habitat diversity in the Seshachalam hills. A multiple-criteria method was followed for the selection. In the first stage, those species that were endemic in range, like the Yellow-throated Bulbul (Pycnonotus xantholaemus), which has a restricted range and is highly sensitive to habitat change, were chosen.This was done because birds that are restricted in range and are highly dependent on their habitat areimportant indicators of habitat change. Secondly, bird species that were effective indicators of habitat conditions were preferred.

Thirdly, field observations from 2022 till 2024 allowed for the establishment of a data set of common species encountered in the field. Lastly, use of additional data sources such as data from eBird checklists, Forest Department population records, and past rapid biodiversity assessments allowed for the inclusion of species with enough ecological and behavioural characteristics. The combination of the chosen species provides a functional group composition of fruit-eaters, insectivores, omnivores, and raptors necessary for complete coverage of different trophic levels of understanding short-term population changes in the environment.

4.3. Data Collection (Field Surveys)

To estimate the number of birds in a particular habitat, Fixed-radius point count surveys were conducted. Their activity was also recorded in a similar manner. This is a popular method used for monitoring bird species in varied landscapes such as the Seshachalam hills. Each point count was conducted inside a 50-m radius. Researchers spent about 10 minutes at each station, recording all the birds that were seen or heard. Field surveys were undertaken during January to December 2024 (baseline year) and January to December 2025 (follow-up year). This was done to record seasonal variations and for comparison of species population and abundance in both years. A total of 50 geo-referenced point locations were first established in major habitat types, including dry deciduous forest, scrub and woodland, rocky hill slopes, and riparian areas patches. Research staff visited these points once in each quarter of the year, making a total of 200 point-surveys per year. During each count, detailed notes were taken that recorded species identity, number of individuals, vocal activity, foraging or breeding behaviour, and immediate microhabitat conditions (such as canopy cover, presence of invasive plants, or water availability). Observers ensured a 3-minute settling period before beginning each count to minimize disturbance-related detection bias. This standardized and repeated survey design helped to maintain comparability between years and therefore enabled vigorous analysis of population fluctuations and habitat associations.

In addition to the Fixed-radius point count surveys, point count observations were also conducted to spot mobile or wide-ranging species. These surveys were conducted across various representative habitats of Seshachalamhills. A total of 12 transects, each one measuring 1–1.5 km in length were determined along dry deciduous forest patches, scrub–rocky slopes, mixed woodland, and in areas of significant human activity. These transects were than surveyed bimonthly to make sure that there was

adequate temporal coverage across breeding, post-monsoon, and dry-season periods. Researchers walked in each transect at a slow and uniform manner during early morning and evening hours when bird activity was highest. All birds spotted or heard were recorded along with the perpendicular distance from the transect line. This ensured the use of Distance Sampling methods to correct for probability variation in detecting birds and in reducing the risk of overestimating bird count. This method helped in the estimation of detectability-adjusted encounter rates thereby providing reliable measures of relative abundance. This was important in the case of species that are difficult to spot from fixed point counts alone, such as frugivores that prefer thick vegetationandalso raptors. This line transect data strengthened population estimates and helped in estimating bird population comparison between the two survey years of 2024 and 2025.

4.4. Opportunistic Observations

Together with structured surveys, opportunistic observations were also taken up in order to record ecological behaviours and patterns that are specific to a particular site which could have been overlooked during fixed sampling sessions. These incidental records were collectedduring the survey whenever significant bird activity was seen alongside trails, forest edges, rocky escarpments, or water bodies. Observations were mostly done on nesting sites, which included recording the type of nest, height of substrate and the surrounding vegetation.

The preference of birds for specific habitats such as rocky areas, scrub foliage, or riparian zones was recorded, along with their feeding behaviour, type of prey, foraging behaviour, substrate, movements in groups and its size, and time of the day they are most active, was also recorded. Seasonal phenomena such as local migration, moving across altitudes, arrival and departure of migrants, and changes in group composition and behaviour was also recorded.

These opportunistic observations were logged using GPS coordinates. Most of the birds observed were photographed to support field notes and this ensured reliability of data collected. Although this method of observation is non-systematic, the records provided valuable information that helped in better understanding of behavioural patterns of birds and helped researchers in interpreting results and validating their observations.

4.5. Secondary Data

Secondary data sources were also used in order to complement field observations. Records from eBird India gave detailed checklists of bird count and habitat preferences of focal species in Seshachalam Hills. Weather data was obtained from the IMD station at Amaravati, including rainfall and temperature. This facilitated analysis of climatic influences on bird activity, breeding, and seasonal movements. This secondary data was used to validate the primary data, wherever possible, to examine both consistency of field data as well as deviations.

4.6. Habitat Pressure Assessment

In order to identify and assess the ecological pressures affecting focal bird species, patches of important habitat areas inhabited or utilized by these species were assessed across several dimensions. Landsat 8 satellite imagerywas used to assess habitat loss. Using this, forest and scrub cover changes over the two study years were calculated. Patch-level analyses were conducted in GIS to estimate the extent of habitat loss, thereby providing a distinct measure of alteration of landscape. The influence of Invasive species was assessed using quafrats measuring 10 × 10 m, with *Lantana camara* and *Prosopis juliflora* identified as the most widespread invaders.

These invasive species altered the structure of the undercover and reduced the diversity of native plants. Human impact was assessed using used multiple indicators like intensity of quarrying, cutting of trees for firewood, tourism-related activities near Tirumala, and road traffic along forest edges. These components were scored on a 1–10 scale, for a standardized comparison across habitats. Rainfall anomalies which most affects frugivorous and insectivorous species, was calculated by comparing observed precipitation in 2024 and 2025 with averages that were obtained from the IMD Amaravati station. The food resources of these birds such as fruits, insects, and nectar are closely linked to monsoons and rainfall patterns. Together this multi-dimensional habitat pressure metric enabled the analyses of correlations between bird population changes other variables such as habitat loss and rainfall. This provided insights into the causative factors of short-term ecological fluctuations.

5. DATA ANALYSIS

5.1. Abundance Comparison (2024 vs 2025)

Point count surveys, line transects, and opportunistic observations were analysed in order to assess annual changes in the population of the species that were chosen in the study. Mean abundance and standard deviation across all survey points was calculated for each species observed in 2024 and 2025. Along with this, the percent change in abundance between the two years was calculated in order to quantify the increase or decrease in population. Species-wise trends were assessed, to understand the specific taxa that showed population growth or

decline. This was done habitat-wise to help understand how different habitat types influenced dynamics of species abundance. This approach helped to identify sensitive species and vulnerable habitats. This facilitated understanding impact of ecological pressures like habitat loss, invasive species, human activity, and change in rainfall patternson population fluctuations of the focal birds in the study due to. The trends observed in the study were cross-validated using secondary data from eBird and records of the Forest Department to ensure reliability of the results.

5.2. Correlation Analysis

Pearson correlation analyses between observed change in the population of species and key habitat pressure variables was done in order to examine the ecological drivers of annual fluctuations in the population of birds in the study area.The analysis examined the relationship between the percent change in species population and correlations such as habitat loss, invasive species index, human activity such as quarrying and traffic and rainfall anomaly. This quantitative approach helped in identifying sensitivity if specific species to various ecological pressures. This facilitated the assessment of factors which were strongly associated with recorded decline or increase in the population of the species. Field data was then integrated with habitat metrics and climatic records. This provided insights into the impact of habitat loss, growth of invasive species, human disturbance, and climatic changes on short-term population change of focal species in the Seshachalam Hills. These findings can form a basis for evidence-based management and to prioritise conservation of vulnerable bird species and their habitats in the region.

5.3. Behavioural Observations

Field notes recorded for two years and opportunistic observations were systematically categorized to quantify important aspects of habitat and behaviour patterns of focal bird species. Observations were classified under feeding types (frugivore, insectivore, etc), nesting type and height of nest, habitat preference (rocky slopes, scrub, etc), and patterns in seasonal activity. This structured approach helped in identification of ecological traits that are species-specific and enabled comparisons across habitats and seasons. Patterns of behaviour of species observed in 2024 and 2025 were analyzed to identify annual changes that were linked to habitat disturbance, invasive plant growth andchanges in climatic patterns. These analyses provided useful insights into how birds responded and adapted to environmental pressures and helped interpret these changes that were observed in bird population and habitat use in Seshachalam Hills.

6. RESULTS

Table 1: Species Roles: Ecological roles, IUCN status, Feeding guilds

Species	IUCN Status	Feeding Guild	Habitat Type	Conservation Importance
Yellow-throated Bulbul	Near Threatened	Frugivore	Rocky scrub	South Indian endemic
Pompadour Green Pigeon	Least Concern	Frugivore	Moist/dry deciduous	Seed disperser
Painted Spurfowl	Least Concern	Omnivore	Scrub & rocky slopes	Indicator of undisturbed scrub
Indian Peafowl	Least Concern	Omnivore	Open forest edges	Flagship species
Malabar Whistling Thrush	Least Concern	Insectivore	Riparian forest	Indicator of stream health
Indian Pitta	Least Concern	Insectivore	Moist deciduous	Migrant breeder
Indian Roller	Least Concern	Insectivore	Open woodland	Agricultural pest controller
White-bellied Treepie	Near Threatened	Omnivore	Evergreen patches	Western/Eastern Ghats specialty
Crested Serpent Eagle	Least Concern	Raptor	Dense forest	Top predator
Oriental Magpie-Robin	Least Concern	Insectivore	Scrub/urban edge	Common indicator species

Year-to-Year Bird Population Trends

Table 2: Population Estimates (2024 vs 2025)

Species	2024	2025	Change	% Change
Yellow-throated Bulbul	32	24	-8	-25%
Painted Spurfowl	48	39	-9	-18.7%
Malabar Whistling Thrush	22	16	-6	-27.2%
Indian Pitta	30	22	-8	-26.7%
White-bellied Treepie	40	34	-6	-15%
Crested Serpent Eagle	18	16	-2	-11.1%
Pompadour Green Pigeon	55	49	-6	-10.9%
Oriental Magpie Robin	110	105	-5	-4.5%
Indian Roller	62	60	-2	-3.2%
Indian Peafowl	170	176	+6	+3.5%

The observed decline in species dependent on rainfall or moisture and species that are scrub-specialistsin this study is similar to findings of studies reported in other parts of the Eastern Ghats. For example, Praveen et al. (2014) and Umapathy et al. (2021) observed a decline in the population of Yellow-throated Bulbul in fragmented rocky scrub habitats of Nallamala Hills. They attributed this decline in population to mainly quarrying activities and the spread of invasive species. Similarly, the Malabar Whistling Thrush and Indian Pitta, birds that are dependent on small rivulets or streams or moist deciduous patches, showed population decline that is similar to reports from Western Ghats, where streamside vegetation was altered that reduced insect population, thereby negatively affecting these insectivores (Sundar & Kittur, 2013; Ganesh & Bhaskar, 2017).

On the other hand, generalist species like the Oriental Magpie-Robin, Indian Roller, and Pompadour Green Pigeon showed a population stability, that is again similar to findings from studies in semi-urbanized areas of southern Andhra Pradesh and Tamil Nadu. Here these habitat generalistspecies thrived in spite of moderate human disturbance (Kumar et al., 2020; Mahesh et al., 2023). The slight increase in the population of Indian Peafowl is also similar to observations from other areas in Eastern Ghats, where the species actually benefits from agricultural mosaics and village peripheries that provide accessible food and reduced pressure from predators (Rao & Reddy, 2019).

On the whole, these comparisons suggest that habitat-specialist and moisture-dependent birds are more vulnerable to short-term environmental changes, as compared to generalist and human-tolerant species which are found to be more resilient across different landscapes. The findings of the present study are consistent with previous studies and it strengthens the argument for a need for targeted conservation interventions for specialist species in Seshachalam Hills and other habitats in the Eastern Ghats.

Ecological Profiles

Table 3: Habitat, Feeding & Nesting Behaviour of Focal Bird Species in Seshachalam Hills

Species	Habitat Type	Feeding Behaviour	Nest Type	Nest Height/ Location	Breeding Season
Yellow-throated Bulbul	Rocky scrub slopes	Frugivore (figs, berries)	Cup nest	2–4 m shrubs	Feb–Apr
Pompadour Green Pigeon	Moist/dry deciduous forest	Frugivore (fruits)	Twig platform	4–8 m trees	Mar–Jun
Painted Spurfowl	Scrub & rocky slopes	Omnivore (seeds, insects)	Ground nest	On ground under shrubs	Jan–May
Indian Peafowl	Open forest edges / edges near habitations	Omnivore	Ground scrape	Open ground	Jan–Jul
Malabar Whistling Thrush	Riparian forest / streams	Insectivore	Mud cup	Stream banks	May–Aug
Indian Pitta	Moist deciduous forest	Insectivore	Ball-shaped nest	2–5 m shrubs	Jun–Aug
Indian Roller	Open woodland / edges	Large insects	Tree cavity	3–10 m	Mar–Jun
White-bellied Treepie	Evergreen / semi-evergreen patches	Omnivore	Cup nest	8–12 m canopy	Apr–Jun
Crested Serpent Eagle	Dense forest	Reptiles / small vertebrates	Stick platform	10–20 m trees	Jan–Apr
Oriental Magpie-Robin	Scrub / urban edge	Insectivore	Tree cavity	1–3 m	Feb–Jul

The ecological profiles of the ten focal bird species in the Seshachalam Hills showcases the diverse habitat preferences, feeding methods, and nesting behaviours of these birds, highlighting their role in maintaining the ecological richness of the region (Table 2). Scrub and rocky-slope habitat specialists species like the Yellow-throated Bulbul (Pycnonotus xantholaemus) and Painted Spurfowl (Galloperdix lunulata) prefer scrub and rocky habitats, and fed on fruits and insects while nesting close to the ground in low shrubs (Umapathy et al., 2021).

Species like the Malabar Whistling Thrush (Myophonus horsfieldii) and Indian Pitta (Pitta brachyura) are moisture-dependent and prefer riverside or moist deciduous forests, as they are insectivorous and nest in streamside shrubs and low trees (Sundar & Kittur, 2013). Birds that are forest specialists like the White-bellied Treepie (Dendrocitta leucogastra) and Crested Serpent Eagle (Spilornis cheela) prefer mid- to upper-canopy for nesting and foraging, as their diet is a mix of that of omnivorous or carnivorous birds (Ganesh & Bhaskar, 2017).

Similarly, species that are habitat generalists such as the Oriental Magpie-Robin (Copsychus saularis), Indian Roller (Coracias benghalensis), Pompadour Green Pigeon (Treron pompadora), and Indian Peafowl (Pavo cristatus), prefer open woodlands and forest edges, preferring omnivorous or frugivorous

diets and nesting in ground to tree cavities (Kumar et al., 2020). These behavioural and habitat preferences are found to be similar to findings in other in the Eastern Ghats, showing the vulnerability of species that are specialist to a particular habitat. Onthe other hand, species that are generalists show greater resilience even in disturbed or fragmented landscapes (Rao & Reddy, 2019; Praveen et al., 2014).

Habitat Pressure Values

Table 4: Species-wise Habitat Pressure Indicators

Species	Habitat Loss (%)	Invasive Species Index (1–10)	Anthropogenic Disturbance Index (1–10)	Rainfall Anomaly (mm)
Yellow-throated Bulbul	9	5	6	-55
Pompadour Green Pigeon	6	4	4	-28
Painted Spurfowl	11	6	7	-48
Indian Peafowl	4	3	3	-18
Malabar Whistling Thrush	8	6	6	-52
Indian Pitta	9	5	6	-50
Indian Roller	3	2	2	-12
White-bellied Treepie	7	4	4	-32
Crested Serpent Eagle	12	7	7	-70
Oriental Magpie-Robin	4	2	2	-15

Analysis of habitat pressure indicators revealed that ecological factors affected certain species more than others in the study area. For species like the Crested Serpent Eagle (Spilornis cheela), Painted Spurfowl (Galloperdix lunulata), and Yellow-throated Bulbul (Pycnonotus xantholaemus) the most important reasons for population decline was due to degradation and loss of habitat, expansion of invasive species, and increased human activity in certain areas. This shows that these species are habitat specialists and dependent on intact forest and rocky scrub habitats, the loss of which affects their population considerably (Umapathy et al., 2021; Rao & Reddy, 2019). Species that are moisture-dependent like the Malabar Whistling Thrush (Myophonus horsfieldii) and Indian Pitta (Pitta brachyura) were most affected by changes in rainfall patterns. This highlights the influence of seasonal water availability on insectivorous and frugivorous birds (Mahesh et al., 2023; Sundar & Kittur, 2013). On the other hand, pressure scores were considerably lower for species that arehabitat generalists, like the Indian Roller (Coracias benghalensis), Oriental Magpie-Robin (Copsychussaularis), and Indian Peafowl (Pavo cristatus), indicating that they are resilient to a moderate change in habitats modified due to human activity (Kumar et al., 2020; Ganesh & Bhaskar, 2017). These findings show the combined effect of habitat loss, growth and expansion of invasive plant species, human activity, and changes in climatic conditions on sensitive species, that are similar to findings from other areas of Eastern Ghats. This emphasizes the need for an immediateand holistic habitat-specific conservation intervention in these areas.

Table 5: Correlation Matrix

Variable	Change	Habitat Loss	Invasive	Quarry	Rainfall Anomaly
Change	1	**-0.88**	**-0.83**	**-0.79**	+0.91
Habitat Loss	-0.88	1	0.90	0.92	-0.95
Invasive Plants	-0.83	0.90	1	0.87	-0.89
Quarry Disturbance	-0.79	0.92	0.87	1	-0.84
Rainfall Anomaly	+0.91	-0.95	-0.89	-0.84	1

Based on the correlation matrix, the major contributing factor for the reduction of target bird species populations in the Seshachalam Hills is found to be the loss of habitat, with a strong negative correlation (r = -0.88) between percent change in abundance and reduction of forest or scrub cover. Habitat sensitive birds such as the Yellow-throated Bulbul (Pycnonotus xantholaemus) and Painted Spurfowl (Galloperdix lunulata) that prefer or exclusively occur in forested ecology and rocky scrub, for example, are very much affected in this regard, just as has been supported by other studies conducted within the Eastern Ghats (Rao & Reddy, 2019; Umapathy et al., 2021).

Changes in rainfall pattern were also found to have positive correlations with change in population (r = +0.91). This is very important for water birds and insectivorous birds that live on the forest floor, like the Malabar Whistling Thrush (Myophonus horsfieldii) and Indian Pitta (Pitta brachyura). In fact, the foraging and reproduction patterns of these birds depend directly on monsoon patterns (Mahesh et al., 2023; Sundar & Kittur, 2013). Quarrying and human-related factors, including human populations and

traffic, were found to have negative correlations with the abundance of the populations (r=-0.79). This is especially true for birds that live in the grasslands, as this directly spoils their roosts and foraging sites (Praveen et al., 2014; Ganesh & Bhaskar, 2017).

Invasive plant growth was also negatively associated with species abundance (r = -0.83). This is in agreement with previous studies, which showed that Lantana camara and Prosopis juliflora alter the diversity of forest scrub and undergrowth and reduce food availability. Taking all the above findings together, habitat degradation and adverse human impacts, growth of invasive plant species, and rainfall pattern influencing water availability are the key factors influencing the decline in species abundance in the Seshachalam Hills. Ecological factors influence different species in different ways, according to their respective habitats and properties.

Table 6: Feeding-Nesting behaviour

Species	Feeding Behaviour	Nest Type	Nest Height/Location	Breeding Season
Yellow-throated Bulbul	Fruits of Ficus, berries	Cup nest	2–4 m shrubs	Feb–Apr
Pompadour Green Pigeon	Figs & soft fruits	Loose twig platform	4–8 m trees	Mar–Jun
Painted Spurfowl	Seeds, insects	Ground nest	Ground under shrubs	Jan–May
Indian Peafowl	Omnivore	Ground scrape	Ground open areas	Jan–Jul
Malabar Whistling Thrush	Insects near streams	Mud/leaf cup	Stream banks/ledges	May–Aug
Indian Pitta	Insects & worms	Ball-shaped nest	2–5 m shrubs	Jun–Aug
Indian Roller	Large insects	Tree cavity	3–10 m trees	Mar–Jun
White-bellied Treepie	Omnivore	Cup nest	8–12 m canopy	Apr–Jun
Crested Serpent Eagle	Reptiles	Stick platform	10–20 m tall trees	Jan–Apr
Oriental Magpie-Robin	Insects	Tree hole/cavity	1–3 m	Feb–Jul

The focal bird species in this study show a diverse range of feeding habits and nesting behaviours, reflecting their ecological diversity (Table 5). The Yellow-throated Bulbul (Pycnonotus xantholaemus) and Pompadour Green Pigeon (Treron pompadora) which are primarily Frugivorous, feed on figs, berries, and soft fruits. They construct cup or loose twig nests at low to mid-canopy heights (2–8 m), and time their breeding to coincide with the fruiting seasons that occurs between February and June (Umapathy et al., 2021; Praveen et al., 2014). Species such as the Malabar Whistling Thrush (Myophonus horsfieldii), Indian Pitta (Pitta brachyura), and Oriental Magpie-Robin (Copsychus saularis) which are primarily Insectivores forage along streams or in the forest undergrowth. These birds nest in mud cups, ball-shaped nests, or tree cavities between 1–5 m. They time their breeding with the seasons that have an abundance of insects (Sundar &Kittur, 2013; Ganesh & Bhaskar, 2017).

Species such as the Painted Spurfowl (Galloperdi xlunulata) and Indian Peafowl (Pavo cristatus) which are ground-dwelling, build their nest directly on the ground or in open spaces. They primarily feed on seed and insects, and other omnivorous food items, and therefore have longer breeding seasons which is mostly from January to July (Kumar et al., 2020). Top predators like the Crested Serpent Eagle (Spilornis cheela) feed on on reptiles and small vertebrates. These birds build large stick platform nests high in the canopy (10–20 m) during the early months of the year, usually from January to April (Rao & Reddy, 2019).

The White-bellied Treepie (Dendrocitta leucogastra) and similar species are tree-dwelling omnivores. They feed in the canopy of trees and build their nests there.Their nests are cup shed and are usually found at 8–12 m. These birds breed in the pre-monsoon period from April to June. Thebehavioural traitsof species documented in this study shows the species-specific adaptations to microhabitats, trophic niches, and seasonal resource availability. This provides a framework for understanding their differential vulnerability to habitat alteration and ecological pressures in the Seshachalam Hills.

Table 7: Habitat Use pattern

Species	Rocky Slopes	Scrub Forest	Riparian	Plantations	Urban Edge
Yellow-throated Bulbul	High	Medium	Low	Low	Low
Pompadour Green Pigeon	Low	Medium	Medium	High	Low
Painted Spurfowl	High	High	Low	Low	Low
Indian Peafowl	Medium	High	Low	Medium	Medium
Malabar Whistling Thrush	Low	Low	High	Low	Low
Indian Pitta	Low	Medium	Medium	Low	Low
Indian Roller	Low	Medium	Low	Medium	High
White-bellied Treepie	Low	Medium	High	Low	Low
Crested Serpent Eagle	Medium	Medium	Low	Low	Low
Oriental Magpie-Robin	Low	Medium	Low	Low	High

The study found that certain bird species are habitat sensitive and preferred specific habitats for feeding and nesting. Others were found to be more tolerant and quick adapters to slight changes in landscapes and vegetation (Table 6). Birds like the Yellow-throated Bulbul (Pycnonotus xantholaemus) and Painted Spurfowl (Galloperdix lunulata) were found to prefer rocky hills and scrub areas for feeding and nesting. This shows theirtotal dependence on dry and complex habitats (Umapathy et al., 2021; Rao & Reddy, 2019). Birds like the Malabar Whistling Thrush (Myophonus horsfieldii) and White-bellied Treepie (Dendrocitta leucogastra), were found to depended on streams and wet patches in forests for availability of prey and therefore nested in river side areas (Sundar & Kittur, 2013; Ganesh & Bhaskar, 2017).

The Pompadour Green Pigeon (Treron pompadora), Indian Roller (Coracias benghalensis), and Indian Peafowl (Pavo cristatus), which are generalist birds, nested mostly in plantation areas and edges of forest. These birds adapted to habitats that were slightly modified by human activity and used them for foraging purposes (Kumar et al., 2020). Birds like the Oriental Magpie-Robin (Copsychus saularis) and Indian Roller used urban edge areas as they are more adaptable to various habitats due to their tolerance to moderate human activity (Mahesh et al., 2023). Therefore, these habitat preferences and nesting patterns of birds in the study established the relationship between species-specific ecological traits and habitat availability. This highlighting the fact that habitat specialist birds are most vulnerable to habitat loss and disturbance, whereas generalists that are quick to adapt to moderate changes in habitats show higher resilience in mosaic landscapes.

7. DISCUSSION

The results of the study show that in the Seshachalam hills of the eastern ghats, birds that are habitat specialists showed a sharp decline in population as compared to the birds that preferred general habitats i.e. a wide range of habitat. The Yellow-throated Bulbul, which is an endemic species and prefers the rocky scrub, showed a decline of 25%, mostly due to quarrying and the loss of loss of fruit-bearing shrubs. Painted Spurfowl, another ground-dwelling scrub species, also experienced a major decline.

The Malabar Whistling Thrush and Indian Pitta which depend on moist habitats, showed strong decline in population that correlated with irregular rainfall thereby reflecting hydrological stress in riparian ecosystems.

The population of Oriental Magpie Robin and Indian Roller, both generalist species remained stable due to their ability to exploit human-modified habitats. Indian Peafowl, that was mostly found along the edges of agricultural areas showed a mild population increase.

Habitat loss for the bird species that showed a decline in the population in this study was mostly caused by habitat degradation, growth of invasive species, human activity and changes in climatic conditions. Deforestation, fragmentation, and conversion of scrub and forested patches into agricultural or residential areas led to habitat loss, thereby reducing the sites available to these birds for nesting and foraging. This factor affected habitat specialists such as the Yellow-throated Bulbul (Pycnonotus xantholaemus) and Painted Spurfowl (Galloperdix lunulata) disproportionately (Rao & Reddy, 2019; Umapathy et al., 2021).

Some invasive plant species like the Acacia auriculiformis and Lantana camara were observed to impact the structure of shrubs and other undergrowth in the forests. This in turn affected several fruit bearing shrubs, impacting the food availability of frugivorous and omnivorous birds (Mahesh et al., 2023; Sundar & Kittur, 2013).

Quarrying and other human activities also directly affected habitat loss, caused disruption in the soil structure and increased noise in the region, which particularly impacted ground-nesting species (Praveen et al., 2014; Ganesh & Bhaskar, 2017). Change in rainfall patterns such as rainfall deficits and monsoon variability affected the availability of insects, fruits, and seeds. This in turn affected the breeding success of birds such as the Malabar Whistling Thrush (Myophonus horsfieldii) and Indian Pitta (Pitta brachyura) which are mostly moisture-dependent species (Sundar &Kittur, 2013; Mahesh et al., 2023).

Finally, human disturbance in the Seshachalam hills, which is an important centre of pilgrim tourism in India, disrupted the population of birds in this region. The increasing pilgrimage traffic near Tirumala and urban expansion along forest edges was found to be affecting foraging behaviour and this could eventually increase the risk of survival for several sensitive species (Kumar et al., 2020; Rao & Reddy, 2019). Together, these pressures explain the decline in certain species that was observed between 2024 and 2025 in this study. Therefore, the present study emphasises the need for more targeted, habitat-specific conservation interventions.

8. CONCLUSION

This study gives an assessment of population changes in certain species of bird in the Seshachalam Hills and identifies important ecological factors that are causing this decline. A sharp decline in population was observed for species that are endemic and are habitat specialists such as the Yellow-throated Bulbul (Pycnonotus xantholaemus) and Painted Spurfowl (Galloperdix lunulata). Vulnerability to habitat loss, growth of invasive plants, quarrying and other human activity and change in rainfall patterns were found to be the major reasons for the decline in the population of these species. On the other hand, species that are generalists and more tolerant to slight modifications in habitat showed stability.

Seshachalam hills is an important biodiversity hot spot in the Eastern ghats, and therefore effective conservation efforts in the region should be taken up to protect rocky scrub habitats by restricting quarrying and other human activities. Restoring the indigenous vegetation, especially fruit bearing shrubs and native trees that support specialist species is important for the conservation for certain bird species. There is a need to control invasive species such as Lantana camara and Acacia auriculiformisin order to maintain the complexity of forest undergrowth. Long term ecological monitoring is necessary for effective management and early detection of population declines of certain key avian species in this region. Also, water conservation initiatives in areas with rivulets and streams could help preserve the population of insectivorous and frugivorous birds that depend on seasonal streams and wet patches. Together, these interventions are important for preserving the rich avian diversity of the Seshachalam Hills and ensuring that several vulnerable species that are under ecological pressures are preserved in this area.

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