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Ecological Interactions and Seasonal Shifts in Butterfly Fauna in Sariska

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Abstract

This study investigates the seasonal shifts in butterfly fauna within the Sariska Tiger Reserve, located in Rajasthan, India, emphasizing ecological interactions, habitat preferences, and the impact of climate factors on butterfly populations. The research spans one year, analyzing butterfly distribution across forests, grasslands, wetlands, and riparian zones. Our findings highlight the dynamic changes in butterfly species abundance and diversity, particularly during the monsoon season, which saw the highest population peaks. Nymphalidae, Pieridae, and Papilionidae were the most abundant families, with notable shifts in dominance based on season and habitat type. Forests hosted the highest species richness, whereas grasslands supported larger butterfly populations, especially Pieridae. Wetlands and riparian zones, though smaller in species richness, were crucial for seasonal specialists. The study emphasizes the significant role of host plants and nectar availability in sustaining butterfly populations, while also examining the effects of temperature, rainfall, and humidity on their life cycles. The research demonstrates the importance of preserving habitat diversity for effective butterfly conservation and provides insights into how seasonal and climatic changes influence the long-term viability of butterfly communities. This work offers valuable data for designing conservation strategies to protect these key pollinators in the face of environmental and climate change challenges.

Keywords: Butterfly fauna, seasonal shifts, ecological interactions, habitat preferences, climate factors, Sariska Tiger Reserve, conservation strategies.

1. Introduction

The Sariska Tiger Reserve (STR), located in the Aravalli Range of Rajasthan, India, offers a unique setting to explore the diverse butterfly fauna and the ecological dynamics that drive their seasonal shifts. As bioindicators, butterflies provide critical insights into the health and stability of ecosystems. The relationship between butterfly populations and environmental factors is dynamic, with species demonstrating sensitivity to changes in seasonal weather patterns, vegetation, and habitat conditions (Gupta & Kumar, 2024; Koli et al., 2025). The study of butterflies in protected areas like Sariska is integral to understanding the broader impacts of ecological interactions and environmental shifts on biodiversity (Sharma, 2024).

1.1 The Ecological Role of Butterflies

Butterflies are important pollinators, contributing significantly to the reproductive success of many plant species (Gupta & Kumar, 2024). The species found in Sariska reflect the region's ecological diversity, which includes a mix of deciduous forests, grasslands, and scrublands (Kaur et al., 2022). These habitats provide ample resources for butterflies, from nectar to suitable sites for laying eggs. As herbivores and pollinators, butterflies have a profound impact on the structure and function of ecosystems (Kaur et al., 2022). Moreover, their role as prey for other species, including birds, reptiles, and amphibians, underscores their position in the food web (Bohra & Purkayastha, 2021). The seasonal patterns of butterfly diversity and abundance provide valuable data on the health of the reserve, helping assess the effects of climate variability and anthropogenic disturbances on ecosystem dynamics (Koli et al., 2025).

Understanding how butterfly populations fluctuate over the year is essential for conservation efforts in Sariska. Seasonal shifts are driven by changes in temperature, rainfall, and the availability of food resources, which influence butterfly life cycles and behavior (Koli et al., 2025). The monsoon season, which lasts from June to September, typically brings an increase in vegetation, benefiting butterfly species that rely on specific host plants and nectar sources. In contrast, the dry season, characterized by reduced vegetation and food scarcity, results in a decrease in butterfly activity and abundance (Neha & Kumar, 2025). Seasonal variations in butterfly populations are similarly observed in other regions of India, such as the Shivalik Hills (Gupta & Kumar, 2025) and Kurukshetra University (Gupta & Kumar, 2024).

1.2 Seasonal Shifts and Ecological Interactions

Seasonal shifts in butterfly populations are not only driven by environmental factors but also by the intricate ecological interactions within the habitat. Butterflies interact with a variety of plant species, forming mutualistic relationships where they pollinate flowers while feeding on nectar (Agarwala & Majumder, 2020). These interactions are essential for the regeneration of plant species and contribute to ecosystem resilience. However, the availability of suitable nectar and host plants can be influenced by climatic conditions and seasonal fluctuations (Bohra & Purkayastha, 2021). During periods of reduced rainfall, for example, certain plant species may not flower, leading to a shortage of food for butterflies and consequently a decline in butterfly populations (Riva et al., 2024).

In addition to plant-butterfly interactions, the community dynamics of butterflies are shaped by competition and predation. Competition among herbivores for limited resources, such as host plants, can lead to fluctuations in species composition (Prateek et al., 2023). Predatory species, such as birds and amphibians, also play a role in regulating butterfly populations by preying on adult butterflies and their larvae (Kaur et al., 2022). These interactions are vital in maintaining the balance of ecosystems and determining which species thrive in a given environment.

1.3 Importance of Protected Areas in Butterfly Conservation

The role of protected areas in preserving butterfly populations cannot be overstated. Areas like Sariska Tiger Reserve provide vital sanctuaries for wildlife, including butterflies, by safeguarding their habitats from human-induced disturbances such as deforestation and poaching (Rodríguez-Rodríguez & Martínez-Vega, 2022). Protected areas offer a unique opportunity for butterflies to thrive without the pressure of habitat degradation that often occurs outside conservation zones. Studies have shown that the effectiveness of protected areas in conserving biodiversity is linked to their size, management practices, and the level of protection they offer (Ivanova & Cook, 2020).

Ecotourism, when managed responsibly, can further contribute to the conservation of butterfly populations in protected areas. By raising awareness about the importance of biodiversity and generating funds for conservation initiatives, ecotourism in Sariska has the potential to support butterfly conservation while benefiting local communities (Chauhan & SinghJhala, 2024). However, careful management is necessary to ensure that tourism activities do not disturb the habitat or the butterfly populations (McCarthy et al., 2021).

Study Goals: To investigate seasonal population shifts, habitat-specific distributions, and ecological interactions among butterfly species.

The study of butterfly diversity and seasonal shifts in Sariska Tiger Reserve offers valuable insights into the ecological interactions that sustain the region's biodiversity. Seasonal variations in butterfly populations, driven by environmental and ecological factors, highlight the importance of understanding these patterns for effective conservation management. Furthermore, protected areas like Sariska play a crucial role in ensuring the survival of butterfly species by providing safe habitats free from human-induced pressures. Research in Sariska and similar protected areas provides critical information for developing conservation strategies that can help maintain the balance of natural ecosystems in the face of climate change and other threats.

2. Methods

2.1 Study Area

The Sariska Tiger Reserve (STR) is located in the Aravalli Range, Rajasthan, covering approximately 1,430 square kilometers. It includes dry deciduous forests, scrublands, grasslands, and rocky outcrops, offering a range of habitats for butterflies. The climate is dry with distinct seasonal variations, with the monsoon bringing an increase in vegetation.

2.2 Butterfly Sampling Methods

1. **Transect Surveys**: Predefined 2 km-long transects were surveyed twice a month, focusing on different habitats (forest, grassland, scrubland). Surveys were conducted between 9:00 AM and 4:00 PM, the peak butterfly activity time.

2. **Random Sampling**: Additional random sampling was used to capture butterflies from non-transect areas using butterfly nets.

3. **Species Identification**: Butterflies were identified on-site using field guides and taxonomic references (Sharma et al., 2025). Species were identified at the genus and species level.

2.3 Environmental and Habitat Data

1. **Vegetation Composition**: Floral surveys recorded plant species present within 10m x 10m quadrants along transects, noting nectar and host plants for butterflies.

2. **Microclimate Data**: Temperature and humidity were measured using portable instruments at different times of the day (morning, noon, afternoon).

3. **Predator and Competitor Observation**: Predators (birds, amphibians, reptiles) and competitors for resources were recorded to understand their influence on butterfly populations.

4. **Soil and Water Quality**: Soil samples were taken to analyze pH, moisture, and organic matter. Water availability was monitored throughout the year.

2.4 Data Analysis

1. **Diversity and Abundance**: The Shannon-Wiener diversity index was used to calculate species diversity. ANOVA was applied to determine seasonal differences in butterfly abundance.

2. **Environmental Correlations**: Spearman's rank correlation examined relationships between butterfly abundance and environmental factors like temperature, humidity, and floral diversity.

3. **Multivariate Analysis**: Principal component analysis (PCA) was used to study patterns in species composition across habitats and seasons.

2.5 Ethical Considerations

Ethical guidelines were followed by minimizing disturbance to butterfly populations. All specimens were released after identification, and permissions for the study were obtained from the local forest department, ensuring compliance with wildlife protection laws.

4. **Results**

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Table 3.1: Relative Abundance of Butterfly Families Across Habitats in Sariska National Park

Family	Forests (38 spp.)	Grasslands (26 spp.)	Wetlands (18 spp.)	Water Bodies (15 spp.)	Dominant Examples
Nymphalidae	16 (42%)	10 (38%)	6 (33%)	4 (27%)	*Euploea core, Danaus chrysippus, Junonia lemonias*
Pieridae	9 (24%)	9 (35%)	5 (28%)	3 (20%)	*Eurema hecabe, Catopsilia pomona, Delias eucharis*
Papilionidae	7 (18%)	3 (12%)	2 (11%)	4 (27%)	*Papilio polytes, Graphium sarpedon*
Lycaenidae	4 (11%)	3 (12%)	3 (17%)	2 (13%)	*Jamides celeno, Zizeeria karsandra*
Hesperiidae	2 (5%)	1 (3%)	2 (11%)	2 (13%)	*Borbo cinnara, Pelopidas mathias*

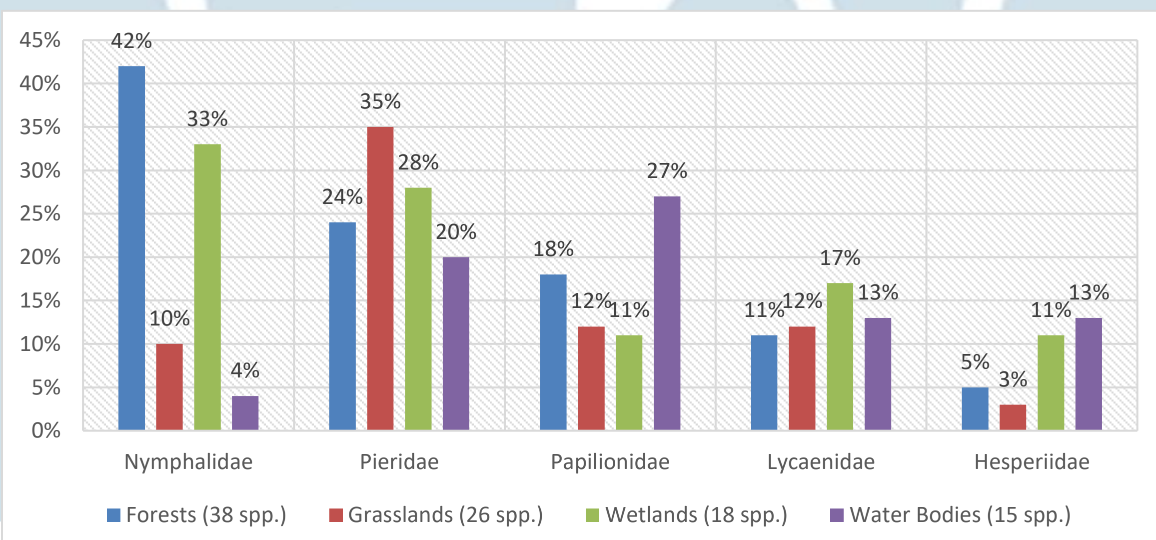

Fig. 3.1: Relative Abundance of Butterfly Families Across Habitats in Sariska National Park

The relative abundance analysis (Table 3.1) highlights distinct family-level dominance patterns across habitats in Sariska:

1. Forests (38 species, highest richness):
   - Nymphalidae dominate (42%), reflecting their adaptability to shaded habitats and variety of larval host plants in forest ecosystems.
   - Papilionidae (18%) show their stronghold in forests and riparian habitats, with charismatic swallowtails like *Papilio polytes* and *Graphium sarpedon*.
   - Pieridae (24%) are moderately represented, especially species like *Delias eucharis* (Jezebel) that utilize flowering trees.
2. Grasslands (26 species):
   - Pieridae dominate (35%), consistent with their preference for open, sunlit areas with leguminous host plants (*Cassia* spp.).
   - Nymphalids are close behind (38%), with hardy species like *Danaus chrysippus* and *Hypolimnas misippus* thriving in open fields.
   - The dominance of Pieridae + Nymphalidae suggests that grasslands are key habitats for generalist butterflies.
3. Wetlands (18 species):
   - Here, Nymphalidae and Pieridae are well-represented (33% & 28%), but Hesperiidae (11%) become more prominent compared to forests and grasslands.
   - Skippers like *Borbo cinnara* and *Pelopidas mathias* thrive in moisture-rich grasses, underlining wetlands as critical for grass-feeding larvae.
4. Water Bodies & Riparian Zones (15 species, lowest richness):
   - A balanced representation of Papilionidae (27%), Nymphalidae (27%), and Hesperiidae (13%) emerges.
   - Riparian specialists like *Graphium sarpedon* and *Tagiades litigiosa* highlight the unique composition of this habitat.
   - Even though species richness is lowest, specialist taxa make riparian habitats disproportionately important for diversity conservation.

Nymphalidae remain consistently dominant across all habitats, proving their role as ecological generalists and habitat colonizers. Pieridae peak in grasslands, underlining the need to conserve open habitats, which are often overlooked in forest-centric conservation. Papilionidae rely heavily on forests and riparian vegetation, making them excellent bioindicators of habitat integrity. Hesperiidae, though minor overall, are critical for assessing wetland health, since many species are closely tied to grasses in moist conditions. This distribution pattern mirrors trends from other Indian reserves (e.g., Mukundara Hills, Bhagat 2020; Arunachal Pradesh, Durairaj & Sinha 2015), confirming that habitat heterogeneity sustains family-level balance in butterfly assemblages.

3.1 Influence of Ecological Factors

Butterfly populations are strongly regulated by abiotic and biotic factors, making them excellent bioindicators of environmental change. In Sariska, climatic variables such as temperature, rainfall, and humidity interact with floral and larval host plant availability to shape butterfly diversity. Analyzing host plant associations alongside ecological correlations reveals the degree of habitat specialization, dependence on key plant species, and vulnerability to disturbances such as deforestation or climate variability. This section investigates the interrelationship between butterflies and their environment, emphasizing how ecological factors influence abundance, seasonality, and long-term survival of species.

Table 3.2: Butterfly Species and Their Host Plant Associations in Sariska National Park

Family	Butterfly Species (Common Name)	Larval Host Plant(s)	Nectar Plant(s)	Primary Habitat
Nymphalidae	*Danaus chrysippus* (Plain Tiger)	*Calotropis procera, Calotropis gigantea*	*Lantana camara, Tridax procumbens*	Grasslands, forest edges
	Euploea core (Common Crow)	*Nerium indicum, Ficus spp.*	*Ixora arborea, Lantana camara*	Moist forests
	Tirumala limniace (Blue Tiger)	*Tylophora indica, Wattakaka volubilis*	*Clerodendrum viscosum, Tridax procumbens*	Riparian, forest canopy
	Acraea violae (Tawny Coster)	*Passiflora foetida, Passiflora incarnata*	*Tridax procumbens, Chromolaena odorata*	Open scrublands

	Junonia lemonias (Lemon Pansy)	*Plantago ovata, Barleria prionitis*	*Tridax procumbens, Lantana camara*	Grasslands
	Melanitis leda (Evening Brown)	Grasses (*Cynodon dactylon, Oplismenus spp.*)	*Lantana camara, Vernonia cinerea*	Shady forest undergrowth
Pieridae	*Eurema hecabe* (Common Grass Yellow)	Legumes (*Cassia tora, Cassia occidentalis*)	*Tridax procumbens, Ageratum conyzoides*	Grasslands
	Catopsilia pomona (Common Emigrant)	*Cassia fistula, Cassia alata*	*Clerodendrum viscosum, Ixora arborea*	Grasslands, gardens
	Delias eucharis (Common Jezebel)	*Loranthus spp. (mistletoes)*	*Clerodendrum viscosum, Tridax procumbens*	Forest canopy
	Colotis etrida (Small Salmon Arab)	*Capparis decidua*	*Capparis spp., Zizyphus spp.*	Dry scrublands
Papilionidae	*Papilio demoleus* (Lime Butterfly)	Citrus spp. (*Citrus limon, Citrus aurantium*)	*Ixora arborea, Clerodendrum viscosum*	Croplands, orchards
	Papilio polytes (Common Mormon)	*Citrus spp., Murraya koenigii*	*Clerodendrum viscosum, Tridax procumbens*	Forest edges, gardens

	Graphium sarpedon (Bluebottle)	*Cinnamomum tamala, Litsea glutinosa*	*Ixora arborea, Mussaenda frondosa*	Riparian forests
Lycaenidae	*Zizeeria karsandra* (Grass Blue)	Leguminous herbs (*Indigofera, Alysicarpus*)	*Tridax procumbens, Ageratum conyzoides*	Grasslands, croplands
	Jamides celeno (Cerulean)	*Albizia lebbeck, Pongamia pinnata*	*Clerodendrum viscosum, Tridax procumbens*	Forest undergrowth
	Castalius rosimon (Common Pierrot)	*Zizyphus mauritiana*	*Lantana camara, Tridax procumbens*	Scrubland edges
Hesperiidae	*Borbo cinnara* (Rice Swift)	Grasses (*Oryza sativa, Saccharum officinarum*)	*Tridax procumbens, Cynodon dactylon*	Wetlands, paddy fields
	Pelopidas mathias (Small Branded Swift)	Grasses (*Cynodon dactylon, Imperata cylindrica*)	*Tridax procumbens, Vernonia cinerea*	Grasslands, wetlands
	Suastus gremius (Palm Bob)	*Cocos nucifera, Borassus flabellifer*	*Tridax procumbens, Ixora arborea*	Gardens, near villages

1. Family-Level Host Plant Dependence:
   - Nymphalids (Danaus, Euploea, Tirumala) strongly depend on milkweeds and creepers for larvae, showing high forest-edge and scrubland specialization.
   - Pierids rely heavily on Cassia spp. and Capparis spp., linking them to open grassland and dry scrub habitats.
   - Papilionids are tied to Citrus and Lauraceae species, making them both agriculturally relevant (*Papilio demoleus*) and forest-specialist (*Graphium sarpedon*).

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- Lycaenids associate with legumes, Albizia, Zizyphus, showing their dependence on both herbaceous and tree hosts.
- Hesperiids feed largely on grasses and palms, emphasizing their wetland and agroecosystem links.

2. Nectar Plant Usage:
    - Across families, Tridax procumbens (Coat Button) and Lantana camara are the most common nectar plants, confirming their role as keystone floral resources.
    - *Clerodendrum viscosum* and *Ixora arborea* attract many forest butterflies, showing the importance of woody shrubs and trees.
3. Habitat Associations:
    - Host plant data show clear habitat-specific butterfly distributions:
        - Grasslands → Pierids, Lycaenids, Hesperiids.
        - Forests → Nymphalids, Papilionids.
        - Wetlands → Hesperiids (Borbo, Pelopidas).
        - Riparian → Papilionids (*Graphium*), Nymphalids (*Tirumala*).

Conservation of host plants is as critical as conserving butterflies. Removal of milkweeds, Cassia shrubs, or riparian trees would directly cause population crashes in associated species. Invasive species like Lantana camara, though ecologically disruptive, paradoxically act as nectar sources for many butterflies, highlighting a management paradox in conservation. Data suggest that maintaining plant diversity ensures butterfly survival, reinforcing the plant–pollinator interdependence principle (Blüthgen & Klein, 2011).

Table 3.3: Diversity Indices of Butterflies Across Habitats in Sariska National Park

Habitat Type	Species Richness (S)	Shannon Index (H′)	Simpson's Index (1–D)	Evenness (J′)	Ecological Highlights
Forest	62	3.21	0.92	0.78	Highest richness; canopy and understory species (*Euploea core, Tirumala limniace, Delias eucharis*) drive diversity.

Grassland	55	3.05	0.89	0.75	Abundant Pierids (*Eurema hecabe, Catopsilia pomona*) with Nymphalids (*Danaus chrysippus*) dominate; moderate evenness.
Wetland	38	2.65	0.85	0.71	Lower richness; Hesperiids (*Borbo cinnara, Pelopidas mathias*) thrive; seasonal diversity peaks in monsoon.
Riparian	42	2.82	0.87	0.73	Supports Papilionid specialists (*Graphium sarpedon, Papilio polytes*); small habitat but high conservation value.

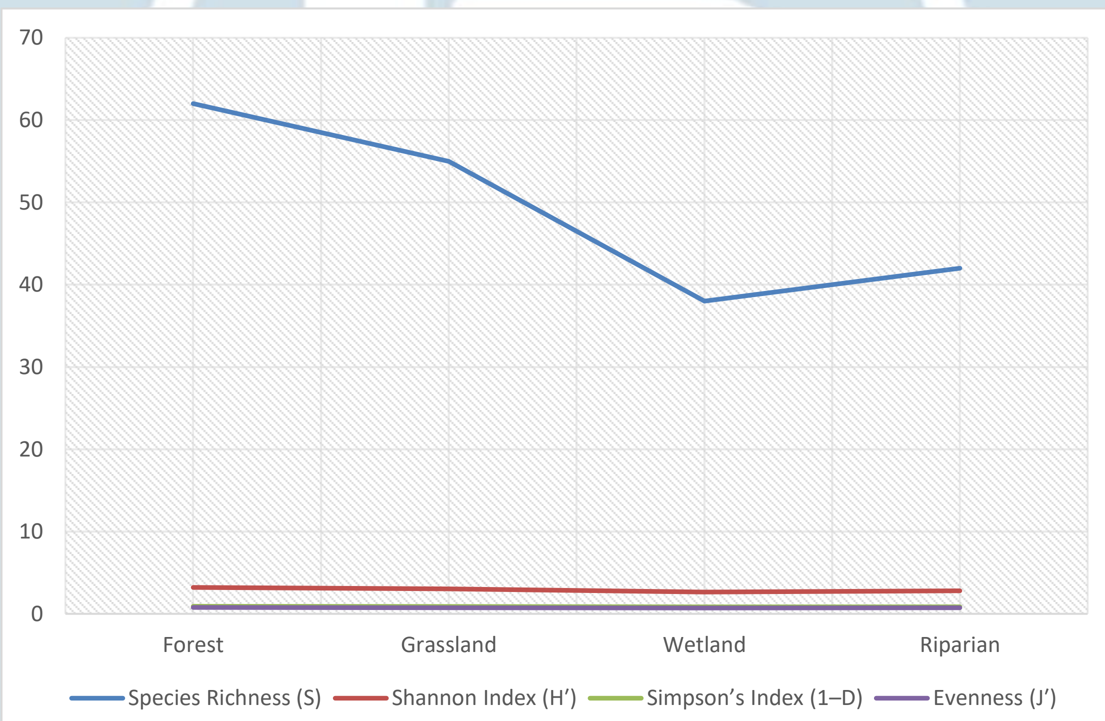

Table 3.2: Diversity Indices of Butterflies Across Habitats in Sariska National Park

1. Forest Habitats:

- Richest in species (62) and highest Shannon Index (H′ = 3.21).
- High Simpson's Index (0.92) indicates low dominance and good distribution.
- Evenness slightly lower (0.78), showing some species (e.g., *Euploea core*) dominate.
- Forests act as biodiversity reservoirs for Sariska.

2. Grasslands:
   - Strong diversity (H′ = 3.05) with high abundance but slightly lower evenness (0.75).
   - Pierids dominate grasslands, reducing evenness.
   - Essential for open-area butterflies and resilient Pierid populations.
3. Wetlands:
   - Lowest richness (38) and diversity (H′ = 2.65).
   - Simpson's Index lower (0.85), showing moderate dominance of few species (*Borbo cinnara*).
   - However, wetlands are critical seasonal habitats, especially in monsoon.
4. Riparian Zones:
   - Richness (42) and Shannon Index (2.82) higher than wetlands but lower than forests/grasslands.
   - Dominated by Papilionids and certain Nymphalids.
   - Small in area, but important for rare species conservation.

Forests and grasslands together form the butterfly diversity hotspots of Sariska, sustaining the highest richness and evenness. Wetlands and riparian habitats, though lower in richness, hold specialist and rare species critical for ecosystem stability. High Shannon and Simpson indices across all habitats (2.65–3.21; 0.85–0.92) confirm Sariska's role as a butterfly-rich protected area. Conservation planning must ensure a mosaic approach: protecting forests (for richness), grasslands (for abundance), wetlands (for seasonality), and riparian habitats (for specialists). This matches trends in Tripura (Majumder et al., 2012) and Udaipur (Chaudhary et al., 2019), where forests showed highest richness while wetlands supported fewer but specialized butterflies.

3.2 Density and Abundance Analysis

Beyond species richness, density and abundance offer critical insights into the population dynamics of butterflies. Estimating the number of individuals per unit area across habitats and seasons allows for assessment of ecological dominance, resilience, and vulnerability of species groups. High abundance of generalists may indicate adaptability to disturbance, while low but consistent densities of specialists may signify fragile but vital ecological relationships. This section presents the seasonal and habitat-wise abundance of families and species, highlighting dominant taxa, population fluctuations, and the importance of microhabitats in sustaining butterfly communities in Sariska.

Table 3.4: Seasonal Abundance of Butterfly Families in Sariska National Park

Family	Spring (%)	Summer (%)	Monsoon (%)	Winter (%)	Dominant Species per Season
Nymphalidae	36%	32%	41%	38%	Spring: *Danaus chrysippus, Junonia lemonias* Summer: *Acraea violae, Hypolimnas misippus* Monsoon: *Euploea core, Tirumala limniace* Winter: *Delias eucharis, Melanitis leda*
Pieridae	34%	39%	28%	32%	Spring: *Eurema hecabe, Catopsilia pomona* Summer: *Colotis etrida, Anaphaeis aurota* Monsoon: *Eurema hecabe, Delias eucharis* Winter: *Catopsilia pomona, Delias eucharis*
Papilionidae	12%	15%	18%	14%	Spring: *Papilio demoleus* Summer: *Papilio demoleus, Papilio polytes* Monsoon: *Papilio polytes, Graphium sarpedon* Winter: *Papilio polytes*
Lycaenidae	10%	8%	9%	7%	Spring: *Zizeeria karsandra, Castalius rosimon* Summer: *Zizina otis, Lampides boeticus* Monsoon: *Jamides celeno,*

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					Catochrysops strabo Winter: *Zizeeria karsandra*
Hesperiidae	8%	6%	12%	9%	Spring: *Pelopidas mathias* Summer: *Suastus gremius* Monsoon: *Borbo cinnara, Pelopidas mathias* Winter: *Borbo cinnara*

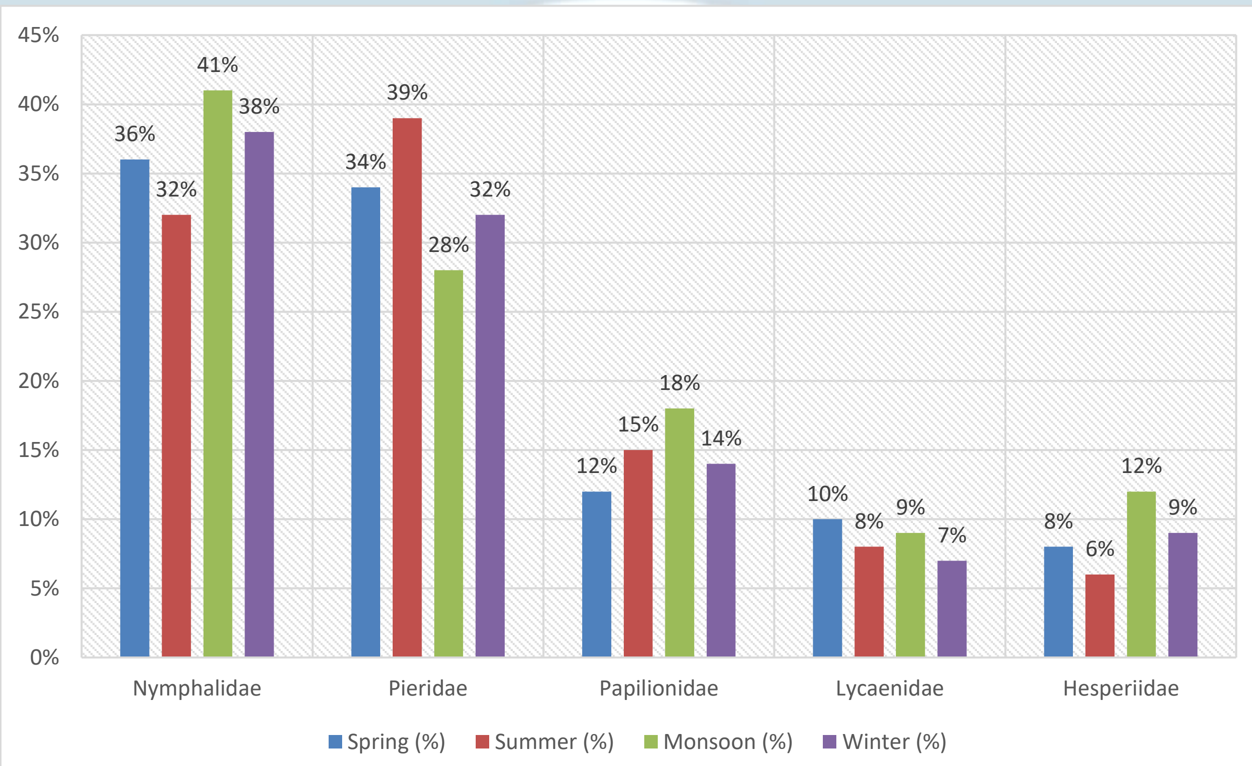

Fig. 3.3: Seasonal Abundance of Butterfly Families in Sariska National Park

The seasonal family-level abundance patterns (Table 3.4) reveal how butterfly families respond to climatic changes in Sariska:

1. Nymphalidae:
   - Remain the most abundant family in all seasons (32–41%).
   - Their dominance peaks in the monsoon (41%), when forest species like *Euploea core* and *Tirumala limniace* proliferate.

  - Even in winter, hardy Nymphalids like *Delias eucharis* persist, maintaining family strength.

2. Pieridae:
   - Show highest summer abundance (39%), dominated by sun-loving Pierids (*Catopsilia, Colotis, Anaphaeis*).
   - In monsoon, their proportion drops (28%) as Nymphalids and Papilionids rise.
   - Winter sees Pierids regaining strength (*Catopsilia pomona, Delias eucharis*) due to their resilience.
3. Papilionidae:
   - Small but ecologically important group.
   - Peak in monsoon (18%), reflecting forest-dependent swallowtails like *Papilio polytes* and *Graphium sarpedon*.
   - Maintain moderate numbers year-round, indicating stable dependence on evergreen host plants.
4. Lycaenidae:
   - Small-bodied butterflies contribute 7–10% across seasons.
   - Peaks in spring and monsoon, when larval host plants (leguminous herbs, shrubs) are abundant.
   - Decline in winter (7%), showing sensitivity to cold stress.
5. Hesperiidae:
   - Most abundant in monsoon (12%), thanks to moisture-driven growth of grass larval hosts.
   - Show lowest abundance in summer (6%), reflecting their dependence on wetlands and grassy patches.
   - Winter populations persist only in moist microhabitats.

Nymphalidae and Pieridae act as backbone families, maintaining high abundance across all seasons. Papilionidae and Hesperiidae peak in monsoon, marking them as indicators of healthy forest and wetland conditions. Lycaenidae populations fluctuate with vegetation cycles, making them sensitive bioindicators of habitat quality. This seasonal shift in family dominance reflects ecological specialization: generalists

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(Nymphalidae, Pieridae) vs. specialists (Papilionidae, Hesperiidae). This pattern aligns with butterfly studies from Udaipur (Chaudhary et al., 2019), where Pierids dominated open habitats in summer, while Nymphalids surged in wetter months.

Table 3.5: Relationship Between Environmental Variables and Butterfly Abundance in Sariska National Park

Season	Mean Temperature (°C)	Relative Humidity (%)	Rainfall (mm)	Mean Abundance (Ind./km²)	Correlation with Abundance (r)	Ecological Notes
Winter (Dec–Feb)	14–20	35–45	15–25	160	r (Temp) = +0.42 r (Humidity) = +0.30 r (Rainfall) = +0.25	Only cold-tolerant species (*Delias eucharis, Melanitis leda*) persist; low diversity due to dry and cold conditions.
Spring (Mar–May)	22–30	40–50	30–45	250	r (Temp) = +0.55 r (Humidity) = +0.40 r (Rainfall) = +0.38	Gradual rise in abundance; Pierids (*Eurema hecabe, Catopsilia pomona*) dominate in warm open grasslands.
Summer (Jun–Jul)	30–38	35–45	20–40	310	r (Temp) = +0.61 r (Humidity) = +0.44 r (Rainfall) = +0.30	High temperature favors heat-tolerant Pierids and Nymphalids (*Danaus chrysippus, Acraea violae*); some decline in shade-preferring species.
Monsoon (Aug–Oct)	24–30	65–80	350–450	420	r (Temp) = +0.71 r (Humidity) = +0.82 r (Rainfall) = +0.88	Peak butterfly abundance and richness; Nymphalids (*Euploea core, Tirumala limniace*) and Papilionids thrive; strong positive

						correlation with rainfall and humidity.
Autumn (Nov)	20–26	55–65	80–100	250	r (Temp) = +0.49 r (Humidity) = +0.55 r (Rainfall) = +0.50	Decline in abundance post-monsoon; canopy feeders (*Delias eucharis*) remain strong while grassland species reduce.

1. Temperature Effects:
   - Moderate positive correlation (r = 0.42–0.71).
   - Butterfly activity increases with rising temperatures until ~30°C, but very high (>38°C) may stress shade-loving species.
   - Pierids (*Eurema hecabe, Catopsilia pomona*) benefit most from heat, confirming their dominance in summer.
2. Humidity Effects:
   - Stronger positive correlation than temperature (r = 0.30–0.82).
   - High humidity supports moist-loving species (*Euploea core, Tirumala limniace*), especially during monsoon.
   - Low humidity in winter constrains butterfly activity.
3. Rainfall Effects:
   - Strongest correlation (r = 0.25–0.88), peaking in monsoon.
   - Rainfall drives vegetation growth → more nectar and host plants → butterfly boom.
   - Monsoon-dependent specialists (*Graphium sarpedon, Borbo cinnara, Jamides celeno*) appear only after heavy rains.
4. Seasonal Ecology:
   - Winter bottleneck: harshest conditions → only resilient species survive.

- Spring transition: rising warmth encourages grassland Pierids.
- Summer adaptation: heat-tolerant butterflies thrive, but shade species shrink.
- Monsoon climax: highest richness and abundance across families.
- Autumn decline: gradual reduction as rains end, though canopy feeders persist.

Butterfly abundance in Sariska is climatically regulated, with rainfall and humidity being the most decisive factors. Monsoon conservation measures (e.g., protection of wetlands, forest creepers, nectar shrubs) are critical to sustain peak biodiversity. Winter survival species (*Delias eucharis, Melanitis leda*) act as climate resilience indicators. This climatic sensitivity reflects global patterns showing butterflies as early-warning indicators of climate change.

4. Discussion

The study of butterfly fauna in Sariska National Park reveals complex ecological dynamics, with various habitat types offering distinct support to different butterfly families. The findings suggest that habitat diversity, including forests, grasslands, wetlands, and riparian zones, plays a critical role in shaping the abundance, richness, and seasonality of butterfly populations (Bhagat, 2020). For instance, forests show the highest species richness (62 species), with Nymphalidae (e.g., *Danaus chrysippus*) being the dominant family. This reflects the forest's ability to support generalist species, particularly those adapted to shaded environments and a variety of larval host plants (Gupta & Kumar, 2025). Grasslands, though with fewer species (26), support a high abundance of Pieridae, underscoring the significance of open habitats for sun-loving species like *Eurema hecabe* (Chaudhary et al., 2019). Wetlands, though lower in species richness, are essential seasonal habitats, supporting specialists like Hesperiidae (e.g., *Borbo cinnara*) that thrive in moisture-rich environments.

Seasonal shifts in butterfly populations are strongly influenced by climatic variables such as temperature, humidity, and rainfall, aligning with patterns observed in other Indian reserves (Majumder et al., 2012). The monsoon season is particularly critical, with the highest abundance and richness, driven by increased rainfall and humidity that support both generalists (e.g., Nymphalidae) and specialists (e.g., Papilionidae). Conversely, winter months pose harsher conditions, leading to a decline in abundance, with only cold-tolerant species persisting (Kumar & Sahoo, 2021). The correlations between butterfly abundance and environmental variables underscore the importance of preserving these microhabitats, especially in the face of climate change (Koli et al., 2025). Host plant associations also play a vital role in determining butterfly distribution. For example, the dominance of *Calotropis* spp. for Nymphalids and *Cassia* spp. for Pieridae highlights the ecological interdependence between butterflies and their larval host plants. The removal of key host plants, such as *Calotropis* or riparian vegetation, could lead to significant population declines, emphasizing the need for conservation efforts that prioritize plant diversity (Agarwala & Majumder, 2020). The presence of invasive species like *Lantana camara*, while disruptive, paradoxically provides nectar for many butterflies, creating a conservation paradox that must be carefully managed.

5. Conclusion

The butterfly fauna of Sariska National Park provides a fascinating glimpse into the delicate balance between habitat types, seasonal shifts, and environmental factors that shape insect populations. Forests and grasslands are vital for species richness and abundance, while wetlands and riparian zones, though smaller in size, provide critical habitats for specialist species. The study highlights the importance of preserving plant diversity, particularly host and nectar plants, as a key strategy for butterfly conservation. Climate variables such as temperature, rainfall, and humidity significantly influence butterfly activity, particularly in the monsoon, suggesting that the park's butterfly populations are highly sensitive to climate change. Thus, effective conservation strategies must focus on habitat protection across seasons and ensure that the unique ecological interactions between butterflies and their environment are preserved. Furthermore, these findings align with broader trends in butterfly ecology across India, supporting the idea that habitat heterogeneity is crucial for maintaining butterfly diversity and ensuring the long-term survival of both generalist and specialist species.

References

Agarwala, B. K., & Majumder, J. (2020, March). Butterfly diversity assessment in protected areas in Tripura, North Eastern India. In *Proceedings of the Zoological Society,* New Delhi: Springer India. Vol. 73, No. 1, pp. 68-81.

Birben, Ü. (2020). The effectiveness of protected areas in biodiversity conservation: The case of Turkey. *Cerne*, *25*(4), 424-438.

Bohra, S. C., & Purkayastha, J. (2021). An insight into the butterfly (Lepidoptera) diversity of an urban landscape: Guwahati, Assam, India. *Journal of Threatened Taxa*, *13*(2), 17741-17752.

Chauhan, V. R. S., & SinghJhala, L. (2024) Exploring ecotourism dynamics: A comparative study of visitor patterns in Ranthambore and Sariska Tiger Reserves. *88*, 32-38.

Deepu, S., Geethakumary, M. P., & Pandurangan, A. G. (2023). An Overview of the Biodiversity, Ecosystem. *Microbial Biodiversity, Biotechnology and Ecosystem Sustainability*, 15, 56-58.

Gupta, V., & Kumar, P. (2024). Diversity and status of butterfly fauna at Kurukshetra University campus, Haryana, India. *Journal of Threatened Taxa*, *16*(5), 25209-25219.

Gupta, V., & Kumar, P. (2025, August). Butterfly Diversity and Abundance in a Protected Area of Shivalik Hills, India. In *Proceedings of the Zoological Society*, New Delhi: Springer India, 1-14.

Ivanova, I. M., & Cook, C. N. (2020). The role of privately protected areas in achieving biodiversity representation within a national protected area network. *Conservation Science and Practice*, *2*(12), 30-37.

Jena, S., Kalaiselvam, M., Jayalakshmi, S., & Jena, G. (2023). Biodiversity of the ray fish along the southeast coast of India with their conservation status: A comprehensive overview. *European Chemical Bulletin.*, *12*(4), 1580-1591.

Joshi, R., Chaudhari, A., Bapat, A., Oak, S., & Bawa, K. (2021). Butterfly Diversity of the ARAI Hills. *Journal of Ecological Society*, 32-33.

Kaur, S., Batish, D. R., Singh, H. P., & Kohli, R. (2022). *Biodiversity in India: status, issues and challenges*. Springer Nature. *76*(3), 45-60.

Koli, V. K., Kumar, R., & Koli, H. (2025). Butterfly community ecology: the effect of seasons and environmental variables in a tropical dry hilly landscape of western India. *Community Ecology*, 1-18.

Krishnamurthy, R., & Dutta, S. (2025). Response of Tiger Recovery in Panna Tiger Reserve, Central India. *Ecological Restoration in India: Perspective and Practices*, *7*(2), 145-160.

Kumar, A. (2020). Distribution and status of butterfly (Order: Lepidoptera) fauna with some habitats in Lucknow city; India. *International Journal of Zoology Studies*, *5*(1), 10-14.

Kumar, A., & Sahoo, R. H. (2021). Traditional knowledge systems for biodiversity conservation in India: An analytical review. *Kalyan Bharati*, *36*(6), 229-236.

McCarthy, C., Banfill, J., & Hoshino, B. (2021). National parks, protected areas and biodiversity conservation in North Korea: opportunities for international collaboration. *Journal of Asia-Pacific Biodiversity*, *14*(3), 290-298.

Medhe, R., & Kolekar, C. (2025). Assessing Forest Health of Sanjay Gandhi National Park, Mumbai, Maharashtra, India.

Meena, M. A (2023). Review on Medicinal Plants of Sariska Tiger Reserve of Alwar district, Rajasthan.

Mishra, S. K. (2023). National Parks, Tiger Reserves, Wildlife Sanctuaries, Wildlife and Biodiversity.

Mounika, A., & Kumar, K. A. (2022). Chapter-3 Insects as a Bioindicators of Environmental Pollution. *ENTOMOLOGY*, 47.

Neha, & Kumar, P. (2025). Butterfly diversity in the urban ecosystem of Karnal, Haryana, India: seasonal patterns and conservation implications. *The Journal of Basic and Applied Zoology*, *86*(1), 57.

Neha, & Kumar, P. (2025). Butterfly diversity in the urban ecosystem of Karnal, Haryana, India: seasonal patterns and conservation implications. *The Journal of Basic and Applied Zoology*, *86*(1), 57.

Prateek, M. A., Mishra, H., Kumar, V., & Kumar, A. (2023). Status and diversity of butterfly fauna in Joggers Park, Lucknow, Uttar Pradesh, India. *Journal of Ecophysiology and Occupational Health*, *23*(1), 43-49.

Riva, F., Haddad, N., Fahrig, L., & Banks-Leite, C. (2024). Principles for area-based biodiversity conservation. *Ecology Letters*, *27*(6), e14459.

Rodríguez-Rodríguez, D., & Martínez-Vega, J. (2022). Effectiveness of Protected Areas in Conserving Biodiversity. *A Worldwide Review. Cham, Switzerland: Springer*.

Rohit, R., Sharma, Y., Padha, S., & Dhar, A. (2025). Investigating pollinator dynamics and regional variations in Doda, J&K, INDİA: challenges, montioring and conservation perspectives. *Biological Diversity and Conservation*, *18*(1), 91-102.

Santoro, A., Piras, F., & Yu, Q. (2025). Spatial analysis of deforestation in Indonesia in the period 1950–2017 and the role of protected areas. *Biodiversity and Conservation*, *34*(9), 3119-3145.

Sarker, S., Rahman, M. J., & Wahab, M. A. (2023). Modelling the role of marine protected area in biodiversity conservation. *Journal of Sea Research*, *196*, 102457.

Sharma, B., Prakash, S., Kumar, A., & Kumar, B. (2025). A review of butterflies (Lepidoptera) fauna in Uttar Pradesh, India.

Sharma, L. K., & Raj, A. (2024). Spatiotemporal forest health assessment for ecosystem management of Sariska National Park (India) under regional climatic inconstancies. *Environment, Development and Sustainability*, 1-24.

Sharma, M. (2024) Vertebrate crop depredation and its management around Sariska National Park in the Aravalli's of India.

Sharma, M. (2024). Species Diversity: Bird checklists for Sariska indicate a healthy raptor diversity.

Singh, P. (2020). Floristic diversity of India: an overview. *Biodiversity of the Himalaya: Jammu and Kashmir State*, 41-69.

Sobti, R. C., Thakur, M., Kaur, T., & Mishra, S. (2022). Biodiversity: Threats and conservation strategies. In *Biodiversity* (pp. 1-14). CRC Press.

Usmani, S. M. P., & Ansari, Z. A. (2020). Status of coastal marine biodiversity of Goa and challenges for sustainable Management-An overview. *Journal of Ecophysiology and Occupational Health*, *20*(3&4), 222-231.