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Indian avifauna and their habitats: An analysis

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Abstract: The abstract concerns the analysis of the avifauna of India and their habitats provides a neat comprehension of the diverse bird species and their ecosystems in the country. Studies have indicated that the Himalayan ecosystem in India is particularly vulnerable to the impacts of climate change, leading to anticipated habitat shifts for species such as the cheer pheasant towards higher elevations. Moreover, research conducted at the Indian Institute of Technology - Guwahati has underscored the significance of habitat diversity in supporting avian species richness, highlighting the necessity for consistent conservation measures across various habitats. Additionally, evaluations of India's protected areas have indicated that while some endangered bird species receive sufficient protection, there is a requirement for alternative conservation strategies to effectively safeguard grassland and open habitat species. Analyses of urban areas in Bhubaneswar emphasize the importance of conserving agricultural lands, forested areas, parks, and wetlands to promote avifauna within urban landscapes. Finally, innovative approaches like designing smart nests using recyclable materials and technology aim to improve nesting habitats and promote bird conservation in India.

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INTRODUCTION

Outdoor recreational activities have been shown to have significant impacts on wildlife, ranging from altered behaviors to changes in population dynamics and ecological processes. Studies have demonstrated that wildlife species exhibit anti-predator responses, such as fleeing and increased vigilance, in response to recreation noise, with larger groups causing higher probabilities of fleeing [1]. Additionally, the presence of humans and their activities influences habitat use patterns of different mammal species, with each species responding uniquely to human disturbances [2]. Furthermore, the spatial and temporal interactions between recreation activities and wildlife communities are crucial for understanding the effectiveness of protected areas in mitigating human impacts on biodiversity. Moreover, outdoor recreation can alter scavenger assemblage composition and scavenging patterns, affecting ecological processes like carrion removal, emphasizing the need for regulating tourism to preserve biodiversity [4]. Integrating data from both government and non-government sources can enhance monitoring of the human footprint of recreation, aiding in landscape-level conservation efforts [5].

Human-induced disturbance can indeed have detrimental effects on wildlife, impacting breeding success and site use by birds. For example, shooting disturbance is crucial for herbivore feeders like wigeon, emphasizing the need for uninterrupted feeding periods to maintain energy balance [1] [5]. Additionally, public and vehicular access in open landscapes negatively affects grazing geese in winter and breeding waders, highlighting the importance of undisturbed areas as refuges to attract wildfowl away from disturbance [1]. Furthermore, the use of scaring devices and other control measures is essential to mitigate the impact of human activities on wildlife, emphasizing the need for strategic management practices to minimize disturbance and support bird populations throughout their life cycles.

Various principal management techniques are employed to mitigate disturbance and compensate for habitat loss in wetland sites, as outlined in the research papers. These techniques include creating new shallow lagoons, grading bank sides, flooding low-lying pastures, reducing salinity levels in coastal lagoons to enhance food availability for birds, manipulating water levels to expose mudflats regularly, establishing feeding areas for geese and wigeon, implementing manipulative livestock grazing, enhancing nesting cover, planting macrophytes, constructing islands, spits, and promontories, expanding refuge areas by acquiring more land, utilizing banks and screens to conceal observers, zoning activities, restricting access, and safeguarding flyways between feeding and roosting sites. These strategies play a crucial role in preserving wetland ecosystems and supporting avian biodiversity, highlighting the importance of comprehensive and sustainable wetland management practices.

BIRDS DIET

Studies on bird diets in the Western Palearctic, as summarized in the Handbook of the Birds of Europe, the Middle East and North Africa, revealed that a total of 105 bird species consume cicadas within the region, with 69 species known to do so specifically in the Western Palearctic. Additionally, a study focusing on Hawfinch populations across Europe found significant differences in dietary composition between countries, highlighting the species' ability to utilize varying food resources [10]. Furthermore, research

on steppe passerine species in central Spain using DNA metabarcoding showed a 74% overlap in dietary niche among the birds, with some species exhibiting more distinct dietary niches, such as the Greater Short-toed Lark and Dupont's Lark [11]. Moreover, an analysis of Lapland Longspur, Snow Bunting, and Horned Lark diets in Norway indicated varying levels of food overlap and potential interspecific food competition, influenced by population trends and climate change effects. These studies collectively emphasize the importance of understanding bird diets for ecological conservation and management purposes.

THE HABITATS OF BIRDS IN INDIA

The diverse habitats in India, including wetlands, farmlands, forests, rivers, and gorges, host a rich avifauna, reflecting the health of these ecosystems. Studies in South Asian cities have shown that urban environmental factors like habitat heterogeneity and impervious surfaces positively influence bird species richness, emphasizing the importance of maintaining habitat quality in highly urbanized areas [11]. Similarly, research in the Hastinapur wildlife sanctuary highlighted higher species richness and abundance in wetland habitats compared to forests, showcasing the variation in bird diversity across different habitats [12]. In production landscapes like the Tillari region, cashew plantations were found to support comparable bird diversity to adjacent forests, while rubber plantations exhibited lower diversity, emphasizing the role of habitat type in shaping bird communities. Furthermore, studies in Bhubaneswar underscored the significance of agricultural lands, forests, parks, and wetlands in supporting avifauna within urban landscapes, emphasizing the need for habitat conservation to protect native bird species [13]. Additionally, research in Vindhyan gorges highlighted the importance of varied habitats, food resources, and undisturbed ecosystems in fostering rich bird diversity, showcasing the key factors contributing to avian abundance in natural settings [14].

COASTLINES

India's peninsular coastline boasts one of the largest mangrove forests globally, including the Sundarbans and Bhitarkanika wildlife sanctuary in Orissa, which are vital habitats for diverse bird species like kingfishers, Mangrove Whistler, and Pitta [1] [2]. However, these mangrove ecosystems are facing significant threats such as degradation due to anthropogenic activities like aquaculture, over-agriculture, tourism, and urban growth [3]. The Bay of Bengal mangroves, encompassing parts of South and Southeast Asia, are particularly vulnerable to population pressure, natural resource exploitation, and climate change-induced cyclones, leading to coastal erosion and mangrove degradation [4]. The disappearance of mangroves not only impacts biodiversity but also leads to adverse environmental consequences like changes in climate, reduced water availability, and increased vulnerability to storm surges, highlighting the critical importance of conserving these ecosystems for both wildlife and coastal communities [5].

Kingfiher

Mangrove Whistler

Pitta

WETLANDS

Wetlands in India encompass a diverse range of ecosystems, including lakes, marshes, lagoons, watersheds, and village ponds, providing crucial habitats for migratory birds from Asia and Europe [15], [16], [17]. These temporary wetlands emerge post-monsoons, attracting waders, ducks, and geese that feed in the shallow waters of these areas, making them ideal spots for birdwatching enthusiasts. Keladeo National Park and Sultanpur National Park stand out as hotspots for birders seeking to witness the beauty and abundance of avian species in these wetland habitats [17]. The rich biodiversity and ecological significance of these wetlands underscore the importance of conservation efforts to preserve these vital ecosystems for both wildlife and human well-being [7], [15].

Wader

Duck

Geese

FORESTS

India's diverse forest types, including coastal mangroves, moist deciduous, dry deciduous, evergreen, and montane forests, host a rich variety of flora and fauna, providing habitats for broadleaf, oak, and woodland birds [18]. These forests are crucial for supporting rural livelihoods and food security, with tree species like Shorea robusta, Tectona grandis, and Mangifera Indica being economically significant [18]. The forests in India play a vital role in enriching human life socially, economically, and spiritually, contributing to biodiversity conservation and sustainable forest management [19]. However, human-induced disturbances, such as overgrazing, overexploitation, and forest fires, pose significant threats to the existing plant populations and wildlife in these forests[18], [20]. Efforts towards sustainable biodiversity conservation, active involvement of tribal communities, and proper management strategies are essential to safeguard the diverse forest ecosystems in India for future generations [18], [20].

CULTIVATED LAND

In India, where nearly 60% of the population depends on agriculture for economic survival [21], the diverse bird species like doves, sparrows, buntings, prinias, quails, francolins, parakeets, rollers, and kestrels thrive in these agricultural landscapes [22], [23]. However, the excessive use of pesticides and fertilizers poses a significant threat to the birdlife in farmlands, leading to a decline in their populations [21]. The presence of organochlorine pesticides in the eggs of wild birds has been documented, highlighting the risks associated with these toxic chemicals on avifauna [24]. To address this issue and protect the biodiversity of birds in agricultural areas, there is a crucial need for sustainable farming practices, reduced pesticide usage, and conservation efforts to ensure the survival of these bird species in India's farmlands.

Sparrow **Francolin** **Parakeet**

GRASSLANDS

The Terai belt, located at the base of the Himalayas, is indeed one of the prime locations to observe a rich variety of bird species, including many endemics. This region, as highlighted in various research papers [25], [26], boasts a diverse avifauna due to its unique habitat characteristics and geographical positioning. The Indian Himalayan region, encompassing the Terai belt, is known for its high biological diversity, with the Eastern Himalayas specifically identified as a global biodiversity hotspot. The Northwestern Himalayan region of Jammu & Kashmir and the trans-Himalayan region of Ladakh also contribute significantly to the bird species richness in the area. The presence of varied topography, temperature gradients, and a plethora of habitats in the Terai belt and surrounding regions in Central, Western, and Peninsular India further enhances the conducive environment for a wide array of bird species, making it a hotspot for birdwatchers and conservationists alike.

DIVERSITY OF INDIAN AVIFAUNA

India is recognized as a mega-diverse country, hosting approximately 1,300 species of birds, which accounts for about 13% of the world's avian diversity reported by BirdLife International (http://datazone.birdlife.org/country/india). These species are distributed across various habitats, including forests, grasslands, wetlands, deserts, and marine ecosystems. The Western Ghats and the North-Eastern region are particularly rich in endemic species, with birds like the Malabar Parakeet and the Great Indian Hornbill being notable examples.

HABITAT DISTRIBUTION AND ECOSYSTEMS

The habitat distribution of birds in India is intricately linked to the country's varied topography and climatic conditions. For instance, the Himalayan region supports high-altitude specialists like the Snow Partridge and the Himalayan Monal, while the wetlands, such as those in Bharatpur, are critical for migratory birds including the Siberian Crane as per Wetlands International analysis. (https://www.wetlands.org/).

POPULATION TRENDS

Population trends of Indian birds have shown varying patterns, with some species experiencing declines, while others remain stable or are increasing. The "State of India's Birds 2020" report, a comprehensive assessment of the status of Indian birds, indicated that 48% of species have remained stable or increased in the long term, whereas 79% have declined in the last five years, signaling an urgent need for conservation action (https://www.stateofindiasbirds.in).

CONSERVATION STATUS

The conservation status of birds in India is a growing concern, with several species facing threats from habitat loss, hunting, and climate change. The International Union for Conservation of Nature (IUCN) Red List has categorized species like the Forest Owlet and the Bengal Florican as critically endangered, highlighting the risk of extinction if immediate conservation measures are not taken (https://www.iucnredlist.org/).

FOREST HABITATS

Tropical evergreen forests, deciduous forests, and coniferous forests in India are crucial for the survival of many bird species. These forests provide nesting sites, food resources, and protection from predators. The Western Ghats and the Northeastern states, known for their dense forest cover, harbor endemic species such as the Malabar Parakeet and the Great Hornbill. Statistical data indicates that forest habitats support approximately 45% of India's avifauna, with a significant proportion of these being endemic or near-endemic species and it was reported by Status of Forests in India, (http://envfor.nic.in).

GRASSLANDS AND SCRUBLANDS

Grassland and scrubland habitats are often overlooked, yet they are vital for the survival of species such as the Lesser Florican and the Bengal Florican. These habitats are under constant threat from agricultural expansion and urbanization. Grassland and Scrubland Habitats, by BirdLife International surveys suggest that grassland species have declined by 30% over the past decade, highlighting the urgent need for conservation measures. (http://birdlife.org).

WETLANDS AND WATER BODIES

Wetlands, including lakes, rivers, and mangroves, are hotspots for avian biodiversity. They serve as breeding grounds and stopover points for migratory birds. The Keoladeo National Park, a Ramsar site, alone supports over 370 bird species. However, wetland encroachment and pollution have led to a concerning decline in waterfowl populations. Wetland Conservation and Management by Wetlands International suggests a 25% decline in migratory waterbirds over the last five years, (http://wetlands.org).

COASTAL AND MARINE ECOSYSTEMS

The extensive coastline of India provides habitat for numerous shorebirds and seabirds. Species such as the Olive Ridley Turtle rely on coastal habitats for nesting. The impact of climate change and sea-level rise poses a significant threat to these ecosystems. Coastal and Marine Bird Conservation by Bombay Natural History Society have shown a fluctuating trend, with some species like the Indian Skimmer experiencing a decline in numbers, (http://bnhs.org).

HUMAN DISTURBANCE EFFECTS ON BIRDS DURING BREEDING SEASON

EFFECTS ON INDIVIDUAL BREEDING AND BREEDING SUCCESS

Studies on the effects of disturbance on breeding birds have explored various activities like walking, vehicular traffic, angling, swimming, boating, windsurfing, and aircraft disturbances. The methods commonly employed to evaluate the impact of disturbance on reproductive success often involve comparing different areas or nest samples with varying disturbance levels. For instance, research on the Emei Shan Liocichla revealed that breeding birds adjusted their nest-site selection strategies in response to continuous researcher disturbance, showcasing the behavioral adaptations of birds to mitigate disturbance effects [27]. Similarly, investigations on the common sandpiper highlighted the importance of nest distance from footpaths and rivers in influencing hatching success, emphasizing the role of disturbance in breeding outcomes [28]. Additionally, experiments with zebra finches exposed to chronic traffic noise demonstrated that parental behavior, such as nest attendance, was influenced by noise levels, indicating potential compensatory strategies to mitigate noise impacts on offspring [29].

EFFECTS ON NEST SITE CHOICE

Disturbance at the nest can indeed influence the choice of future nest sites, as evidenced by studies on various bird species. For example, a study on cavity-nesting birds like the Eastern Bluebird and Tree Swallow showed that human activity, noise, and artificial light at night impact nest-box use and fledgling success differently for each species [30]. Additionally, research on white storks near landfills demonstrated that birds breeding in urban areas near landfills selected nest sites with different characteristics compared to those breeding further away, highlighting the influence of human-altered landscapes on nest-site selection and breeding success [31]. Furthermore, studies on turtles in areas with varying levels of human disturbance revealed that nest predation rates were higher in areas with low to intermediate disturbance levels, indicating that turtles may not adjust their nest site choices in response to anthropogenic changes [32]. These findings collectively emphasize the importance of considering the impact of human disturbance on nest-site selection and breeding outcomes in various bird species.

EFFECTS ON POPULATION DENSITY

Studies on the effects of disturbance on bird densities during the breeding season have primarily focused on waterbirds, waders, and passerines, comparing breeding bird densities in areas with varying disturbance levels or using correlational methods [33]. For example, research on urban-dwelling bird species in European parks revealed that human disturbance negatively impacted the detection probability of certain bird species, highlighting the ability of urban-dwelling birds to adjust their activity patterns in response to human presence. Additionally, studies on ground-nesting migratory waders like the common sandpiper showed that disturbance, habitat characteristics, and rainfall significantly influenced hatching and fledging success, emphasizing the vulnerability of ground-nesting species to human disturbance and extreme weather events during the breeding season. These findings underscore the importance of considering the impacts of disturbance on bird populations, especially during critical breeding periods.

EFFECTS ON COMMUNITY STRUCTURE

Human activities have a significant impact on bird communities, with studies showing that habitat destruction, hunting, and human modification can lead to changes in avifauna diversity [34], [35]. For example, the study by Uehara et al. (2021) demonstrated how the decrease in tourist visits during the pandemic altered the behavior and habitat use of sika deer in Nara Park, Japan. Furthermore, the research by Rather et al. 2022 highlighted the detrimental effects of anthropogenic activities on bird diversity, emphasizing the importance of proper management to ensure the survival of avifauna in wetland areas. Understanding these impacts is crucial for conservation efforts and biodiversity preservation, especially in the face of increasing human modifications to natural habitats.

OTHER EFFECTS

Studies on the reactions of breeding birds to human disturbance have shown varying results regarding changes in response intensity throughout the breeding season. Vos et al. (1985) observed that the intensity of disturbance reactions in great blue herons decreased as the breeding season progressed [36] . In contrast, Erwin (1989) studying terns, waders, and skimmers, and Byrkjedal (1989) studying lesser golden plovers did not find significant changes in disturbance reactions over the course of incubation [6], [37]. These findings highlight the complexity of bird responses to human disturbance, indicating that different species may exhibit diverse patterns of reaction intensity over the breeding season, emphasizing the need for species-specific management strategies to mitigate the impacts of human activities on breeding bird populations.

HUMAN DISTURBANCE EFFECTS ON BIRDS OUTSIDE THE BREEDING SEASON

Studies on the effects of disturbance on habitat use primarily focused on wintering waterbirds such as geese and ducks, with some attention given to gulls and waders [38], [39]. Ducks were particularly studied in relation to water-based recreation activities like boating and angling, which can impact their behavior and habitat preferences[39]. The most commonly used methods in these studies were direct observations and bird counts in both disturbed and undisturbed situations to assess the influence of human activities on the abundance and distribution of waterbirds [38], [39]. These approaches allowed researchers to evaluate how different types of disturbances, such as hunting or recreational activities, affect the behavior and spatial patterns of waterbirds in various habitats, providing valuable insights into the responses of these species to human-induced disruptions.

THE IMPACT OF INDUSTRIAL DEVELOPMENTS

Estuarine engineering operations pose a significant threat to the disturbance of wildlife, particularly waders and wildfowl, in estuarine habitats. Studies have shown that these engineering activities, such as the construction of civil engineering structures like

piers and bridges, can lead to rapid transformations in habitat distribution and ecosystem functions, impacting sedimentation patterns and altering the availability of roosting areas for waterbirds [40]. Additionally, alterations in channel depth and wetland restoration efforts within estuaries can affect sedimentation rates and tidal flow dynamics, influencing the behavior and movement of wildlife in these areas [41]. The scarcity of data on the specific responses of waders and wildfowl to estuarine engineering activities highlights the need for further research to understand and mitigate the disturbances caused by these developments on internationally important estuarine ecosystems [42].

METHODS OF MITIGATING DISTURBANCE EFFECTS

Various strategies are employed to mitigate the impacts of disturbance from recreational activities, public access, and industrial developments on wildlife and ecosystems. These strategies include proactive planning, facility design modifications, improved maintenance, and the establishment of designated trails and water points [43]. Additionally, wetland management frameworks such as the PREE approach (Preservation, Restoration, Enhancement & Establishment) offer a comprehensive strategy to address anthropogenic pressures and threats on wetlands, restore lost functions, enhance existing systems, and establish artificial wetlands for specific ecohydrological functions [44]. Furthermore, studies have shown that disturbances from outdoor recreation can alter scavenger assemblages and scavenging patterns, emphasizing the importance of regulating tourism and maintaining restricted areas to preserve biodiversity and ecological processes in highly anthropized landscapes [3]. These combined efforts aim to minimize the negative impacts of disturbances on wildlife and habitats, promoting sustainable coexistence between human activities and natural ecosystems.

AVIFAUNA CONSERVATION

The Indian government has proposed a comprehensive 10-year plan to protect birds and conserve their habitats across the country. The plan aims to safeguard the 1,317 bird species found in India, with a focus on the 100 species that are currently threatened.

- **Protecting Rare, Endangered and Threatened (RET) Bird Species**
  The plan identifies 270 species (21% of Indian avifauna) as 'rare', including raptors, pheasants, bustards, hornbills, cranes, and storks. 17 species are categorized as 'critically endangered', 20 as 'endangered', and 63 as 'vulnerable' by IUCN. Species recovery programs will be introduced for critically endangered species.
- **Conserving Habitats and Landscapes**
  A landscape approach will be used to control declining bird populations. Wetlands and coastal areas frequented by birds will be conserved. Invasive plant species that deteriorate soil cover and compete with native plants will be removed from the Aravalli landscape in Delhi-NCR.
- **Protecting Urban Avifauna**
  Planning and managing urban green spaces like gardens, parks and corridors will help conserve urban birds. Waste dumping into wetlands and other bird habitats will be controlled.
- **Monitoring and Research**
  Short, medium and long-term surveys and management plans spanning 3, 5 and 10 years will be conducted to preserve avian density and combat habitat loss. Environmental impact assessments will be carried out to study the effects of air, water pollution and climate change on birds and their wintering sites. A state repository of avian reference samples and DNA databases will be generated for forensic purposes to curb illegal bird trafficking.

By implementing these multi-pronged strategies, it is possible to safeguard the country's rich avian diversity and the vital ecosystem services they provide, while also addressing emerging threats like habitat loss, pollution, and climate change.

CONCLUSION

The analysis of Indian avifauna and their habitats reveals the profound diversity of bird species and the critical ecosystems they inhabit across the country. The Himalayan ecosystem's vulnerability to climate change necessitates urgent action to mitigate habitat shifts, particularly for species such as the cheer pheasant. Research from the Indian Institute of Technology - Guwahati emphasizes the importance of habitat diversity in sustaining avian species richness, advocating for continuous conservation efforts across various habitats. Despite some successes in protecting endangered bird species within India's protected areas, there remains a need for alternative conservation strategies to better safeguard grassland and open habitat species. Urban studies, particularly in Bhubaneswar, highlight the crucial role of agricultural lands, forested areas, parks, and wetlands in supporting urban avifauna. Lastly, innovative solutions like smart nests made from recyclable materials and integrated technology represent promising avenues for enhancing nesting habitats and advancing bird conservation efforts in India.

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