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Biodiversity research in Murree-Kotli Sattian-Kahuta National Park, Punjab, Pakistan: A systematic review

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Abstract. National parks, classified under Category II of Protected Areas, have a key role in conserving biodiversity. Murree-Kotli Sattian-Kahuta National Park, located in District Rawalpindi, Punjab Province, Pakistan, holds significant importance due to its diverse species and ecosystems. We sought to systematically assess biodiversity research conducted in this national park, identifying key research gaps and providing recommendations for future studies. We retrieved published articles from internet sources, downloading a total of 410 articles, of which 85 were retained for review. Each article was thoroughly examined by reading its title, objectives, and results to extract the necessary information. The extracted data was added to the spreadsheet for further analysis of each study. The available published literature showed that research has predominantly focused on insects, amphibians, large mammals, and plants in the park. Thus far, research has documented 80 insect species, 13 amphibian species, 15 reptile species, 147 bird species, 12 mammal species, and 819 plant species. We identified the following research gaps in each study: short duration, limited sample size, and reliance on conventional methods. Based on our findings, we strongly recommend the use of modern technology in future research studies to investigate the unexplored aspects of this national park thoroughly.

Keywords: Murree, National Park, *Abies pindrow*, Lepidoptera, *Allopaa hazarensis*, *Nanorana vicina*, *Manis crassicaudata*, *Panthera pardus*.

Introduction

Protected Areas (PAs) play a pivotal role in preserving natural habitats and conserving biodiversity (Geldmann et al. 2019, Maxwell et al. 2020, Xu et al. 2022, Mi et al. 2023, Driscoll et al. 2024, Lindenmayer 2024). The terminology of PAs lacked systematic clarification until the 1933 International Conference for the Protection of Flora and Fauna, which recommended a four-stage typology, i.e., national park, strict nature reserve, fauna and flora reserve, and reserve with prohibition on hunting. Later, IUCN categorized PAs into six distinct categories. National parks are categorized under Category II (Locke & Dearden 2005, Dudley et al. 2010, Hirons et al. 2022). National parks play a critical role in conserving species and their habitats within designated boundaries. Additionally, national parks provide opportunities for scientific exploration, educational endeavors, recreational pursuits, and visitor activities (Burns et al. 2003, Dudley et al. 2010).

Pakistan took its first steps towards establishing PAs in the 1970s, with the formation of the Wildlife Enquiry Committee on 2 October 1968, which was tasked with the mission of laying the groundwork for establishing a network of PAs across the country (Junaid et al. 2023). Initially, the committee recommended the establishment of 5 national parks, 18 wildlife sanctuaries, and 52 game reserves in Pakistan

(Awan et al. 2021). To date, conservation efforts have resulted in the establishment of 178 PAs in Pakistan, which include national parks, wildlife sanctuaries, game reserves, Ramsar-protected wetlands, and biosphere reserves. Together, these areas cover approximately 14% (136,221 km^2) of Pakistan's territory. As of now, Pakistan has established a total of 28 national parks. Punjab Province has four national parks: Chinji National Park, Kala Chitta National Park, Lal Suhanra National Park, and Murree-Kotli Sattian-Kahuta National Park (Anwar et al. 2022, Siddique & Molinos 2024).

Murree-Kotli Sattian-Kahuta National Park, established in 2009, holds significant importance in Pakistan due to its rich species diversity and unique ecosystem conditions (Khatoon et al. 2019b, Rais et al. 2023a). The park is located on the northwestern edge of the Himalayas (33.6986 °N, 73.5195 °E) in District Rawalpindi, featuring mountains and rivers, with elevations ranging from 800 to 2100 m (Khatoon et al. 2022). The total area of the park is 575.81 km^2 (Habiba et al. 2021a). The park experiences a temperate climate with an average annual precipitation of 1249 mm (Rais et al. 2023a). During the summer months, the average temperature in the park is 32°C, while in winter, it is around 10°C (Khatoon et al. 2022). The park at higher altitudes is predominantly characterized by rugged terrain featuring narrow valleys (Akram et al. 2022). Vegetation in the park primarily comprises subtropical chir pine forest, subtropical broadleaf forest, and moist temperate coniferous forest types (Khatoon et al. 2022).

Materials and methods

We followed the methodology of Doherty et al. (2020) to collect studies conducted on Murree-Kotli Sattian-Kahuta National Park (Figure 1). An online search was made to collect published literature using Google Chrome, Firefox, and Microsoft Edge browsers. Articles were downloaded from Google Scholar, ResearchGate, ScienceDirect, Taylor & Francis, Wiley Online Library, Nature Portfolio, SpringerLink, MDPI, Pakistan Journal of Zoology, Pakistan Journal of Botany, and Pakistan Journal of Forestry. We used keywords "Murree-Kotli Sattian-Kahuta National Park", "Murree", "Kotli Sattian", "Kahuta", "National Park", "Rawalpindi", "Punjab", "Pakistan", "Fauna", "Flora", "Wildlife", "Forest", "Wildlife Conservation". We used these key terms individually and in combination by using terms such as "and", "or", and "also". Articles that met our review criteria were retained and studied thoroughly, while the remaining ones were removed, following the PRISMA guidelines as outlined by Liberati et al. (2009). An Excel spreadsheet was created to analyze the extracted information from all the selected articles. We recorded the following information after reading the papers: author names, study area, study year, fauna of Murree-Kotli Sattian-Kahuta National Park, flora of Murree-Kotli Sattian-Kahuta National Park, IUCN status of species, findings, and research gaps in the study.

Results

Our research produced a total of 85 studies on the biodiversity of Murree-Kotli Sattian-Kahuta National Park. To date, studies on the biodiversity of national parks have recorded 80 species of insects, 13 amphibians, 15 reptiles, 147 birds, 12 mammals (Supplementary Material 1), and 819 species of plants, including 93 grass, 507 shrub, 128 herb, and 91 tree species (Supplementary Material 2).

Faunistic studies focused on insects (Qureshi 1980, Ahmed et al. 1981, Rahman & Chaudhry 1986, Ahmed 2008, Qasim et al. 2014, Batool & Hussain 2016, Saadat et al. 2016, Shah et al. 2017, Abbas et al. 2023), amphibians (Rais 2014, Rais et al. 2014, Ahmed et al. 2020, Gill et al. 2020a, Gill et al. 2020b, Akram et al. 2021, Rais et al. 2021, Saeed et al. 2021, Sajjad et al. 2021, Akram et al. 2022, Ikram et al. 2022, Saeed et al. 2022a, Saeed et al. 2022b, Batool et al. 2023, Rais et al. 2023a, Rais et al. 2023b), and mammals (Irshad et al.

2015, Asad et al. 2019, Habiba et al. 2019, Khatoon et al. 2019a, Khatoon et al. 2019b, Mahmood et al. 2019, Ahmad et al. 2020a, Habiba et al. 2020, Waseem et al. 2020a, Waseem et al. 2020b, Habiba et al. 2021a, Habiba et al. 2021b, Sarwar et al. 2021, Khatoon et al. 2022, Danish et al. 2023, Zahoor et al. 2023) in the park. Among insects, the order Lepidoptera is well documented (Ahmed et al. 1981, Rahman & Chaudhry 1986, Batool & Hussain 2016, Saadat et al. 2016, Shah et al. 2017), and information on a few species of Coleoptera (Ahmed 2008, Abbas et al. 2023), Diptera (Qasim et al. 2014), and Hemiptera (Qureshi 1980) is available. Ahmed et al. (1981) reported *Biston regalis* as a defoliator of *Pinus wallichiana*. Two bark beetles, *Ips longifolia* and *Scolytus scolytus*, were recorded as pests of *P. wallichiana* (Ahmed 2008). Batool & Hussain (2016) documented 28 butterfly species, while Saadat et al. (2016) reported 45 butterfly species.

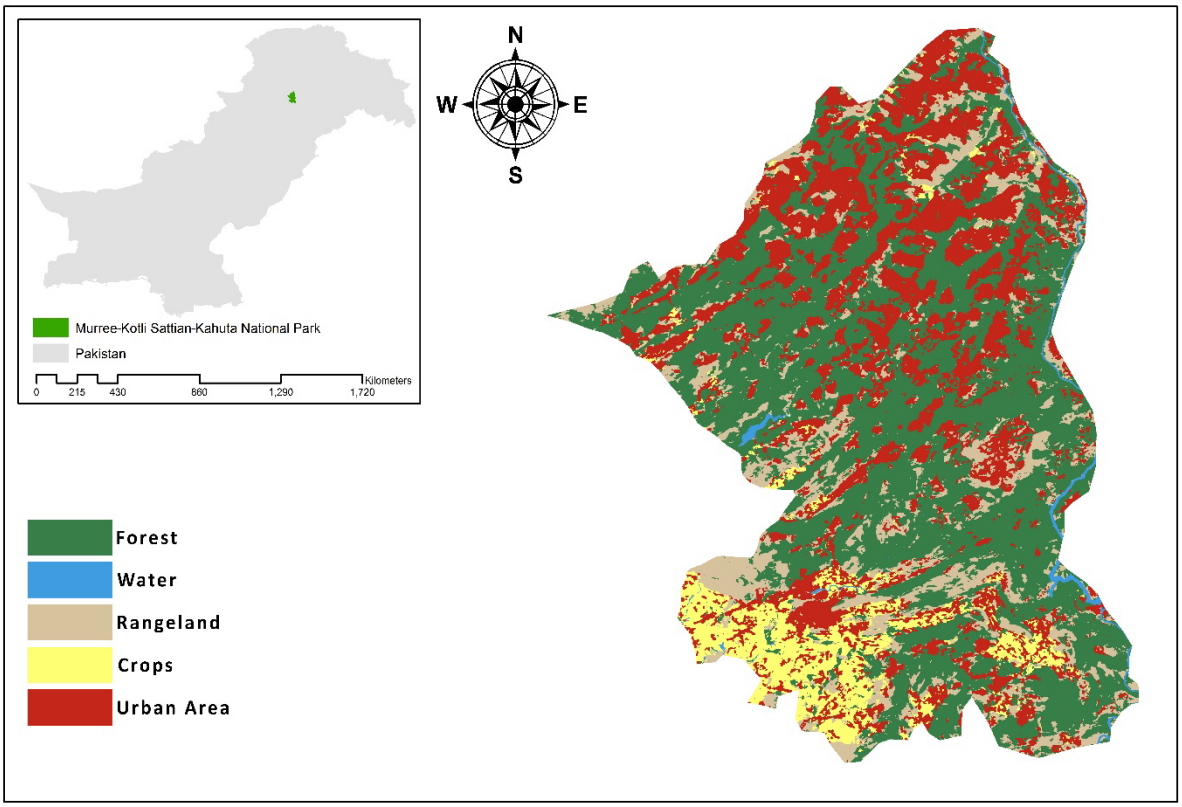

Figure 1. Some major land use land cover types of Murree-Kotli Sattian-Kahuta National Park, Rawalpindi, Punjab, Pakistan.

Amphibians have remained the focus of research among fauna of the park (Rais 2014, Rais et al. 2014, Ahmed et al. 2020, Gill et al. 2020a, Gill et al. 2020b, Akram et al. 2021, Rais et al. 2021, Saeed et al. 2021, Sajjad et al. 2021, Akram et al. 2022, Ikram et al. 2022, Saeed et al. 2022a, Saeed et al. 2022b, Batool et al. 2023, Rais et al. 2023a, Rais et al. 2023b). Two endemic species, i.e., *Allopaa hazarensis* and *Nanorana vicina*, are well-studied in different aspects of ecology (Rais et al. 2014, Ahmed et al. 2020, Gill et al. 2020a, Rais et al. 2021, Saeed et al. 2021, Akram et al. 2022, Ikram et al. 2022, Batool et al. 2023, Rais et al. 2023a, Rais et al. 2023b), with a few molecular studies also conducted (Akram et al. 2021, Saeed et al. 2022a). Rais et al. (2014) provided the initial description of *N. vicina* from the park. Gill et al. (2020a, b) explained the first

detailed description of the external morphology and oral disc structure of the tadpole of *N. vicina*, collected from the park. The first genetic study on *A. hazarensis*, *Duttaphrynus bengalensis*, *Euphlyctis kalasgramensis*, *Microhyla nilphamariensis*, *N. vicina,* and *Sphaerotheca pashchima* was conducted by Akram et al. (2021). Saeed et al. (2021) evaluated the effect of temperature change on the development of *A. hazarensis* and *N. vicina*. Akram et al. (2022) assessed the movement patterns of *A. hazarensis* and *N. vicina* through radiotelemetry. Ikram et al. (2022) developed keys for the identification of tadpoles of *A. hazarensis*, *D. bengalensis*, *E. kalasgramensis*, *Firouzophrynus stomaticus*, *Hoplobatrachus tigerinus*, *M. nilphamariensis*, *Minervarya pierrei*, and *N. vicina*. Saeed et al. (2022a) employed the eDNA method to monitor populations of *A. hazarensis* and *N. vicina*. Batool et al. (2023) recorded the daily and seasonal movements of *A. hazarensis* and *N. vicina*. The information on the spatial distribution patterns of nine anurans, i.e., *A. hazarensis*, *D. bengalensis*, *E. kalasgramensis*, *F. stomaticus*, *H. tigerinus*, *M. nilphamariensis*, *M. pierrei*, *N. vicina*, and *S. pashchima*, was provided by Rais et al. (2023a). Rais et al. (2023b) analyzed the diet of *N. vicina*, captured from the park.

Research on mammals has focused on carnivore and herbivore species (Irshad et al. 2015, Asad et al. 2019, Habiba et al. 2019, Khatoon et al. 2019a, Khatoon et al. 2019b, Mahmood et al. 2019, Ahmad et al. 2020a, Habiba et al. 2020, Waseem et al. 2020a, Waseem et al. 2020b, Habiba et al. 2021a, Habiba et al. 2021b, Sarwar et al. 2021, Khatoon et al. 2022, Danish et al. 2023, Zahoor et al. 2023). Asad et al. (2019) documented the abundance and distribution of *Panthera pardus* in Murree. The diet of *P. pardus* and *Prionailurus bengalensis* was analyzed by Khatoon et al. (2019a). Danish et al. (2023) reported human-leopard conflict in the park. The habitat range of *P. pardus*, along with *Naemorhedus goral*, was studied by Zahoor et al. (2023). Khatoon et al. (2022) provided information on the distribution and diet composition of *Herpestes auropunctatus* and *Herpestes edwardsii* in the park. Habiba et al. (2019) explained anthropogenic threats to the habitat and population of *Muntiacus vaginalis*. The occurrence and population density of *M. vaginalis* were recorded by Habiba et al. (2020). Habiba et al. (2021a, b) documented the feeding habits, habitat use, and seasonal distribution of *M. vaginalis*. Ahmad et al. (2020a) recorded the distribution range of *N. goral*. The abundance, distribution, and diet of *Manis crassicaudata* were documented by Irshad et al. (2015). Mahmood et al. (2019) reported the distribution and poaching of *M. crassicaudata*. Data on the occupancy and habitat preference of *M. crassicaudata* were provided by Waseem et al. (2020a). Waseem et al. (2020b) recorded information on poaching and illegal trade of *M. crassicaudata*.

Flora of the park has been well studied, with the first recorded observations dating back to the 1970s (Khan & Ahmad 1976, Sheikh & Aleem 1978, Sheikh & Bangash 1985, Hussain 1986, Khattak & Mahmood 1986, Ramnani et al. 1986, Chaudhry & Chaudhry 1992, Mumtaz et al. 2000, Hussain et al. 2004, Gulfraz et al. 2006, Ahmad et al. 2007, Ahmed et al. 2011, Hussain et al. 2011, Ahmed et al. 2013, Ashraf et al. 2014, Saqib et al. 2014, Shaheen et al. 2014a, Shaheen et al. 2014b, Muhammad & Khan 2016, Ahmad et al. 2018, Ashraf et al. 2018, Khan et al. 2018a, Khan et al. 2018b, Zarif et al. 2018, Ahmed et al. 2019a, Ahmed et al. 2019b, Ahmad et al. 2020b, Iqbal et al. 2020, Javed et al. 2020, Khan et al. 2020a, Khan et al. 2020b, Muhammad et al. 2021a, Muhammad et al. 2021b, Ansari et al. 2022, Asghar et al. 2022, Fatimah et al. 2022, Malik et al. 2023, Naqvi et al. 2023, Hussain et al. 2024, Satti et al. 2024). *Abies pindrow*, *Adiantum capillus-veneris*, *Berberis lycium*, *Cedrus deodara*, *Pinus roxburghii,* and *P. wallichiana* are among the major floristic species of the park (Muhammad & Khan 2016, Javed et al. 2020, Khan et al. 2020b, Naqvi et al. 2023). The medicinal importance of numerous plant species has been investigated (Khan & Ahmad 1976, Hussain et al. 2004, Gulfraz et al. 2006, Ahmed et al. 2013, Saqib et al. 2014, Ahmad et al. 2018, Khan et al. 2018a, Zarif et al. 2018, Javed et al. 2020, Fatimah et al. 2022).

Mumtaz et al. (2000) analyzed the palynological characteristics of *Artemisia amygdalina*, *Artemisia biennis*, *Artemisia brevifolia*, *Artemisia desertorum*, *Artemisia dubia*, *Artemisia gmelinii*, *Artemisia japonica*, *Artemisia laciniata*, *Artemisia moorcroftiana*, *Artemisia roxburghiana*, *Artemisia scoparia,* and *Artemisia sieversiana*. Ahmed et al. (2011) investigated the dendroclimatic potential of six conifer species, i.e., *A. pindrow*, *C. deodara*, *Juniperus excelsa*, *Picea smithiana*, *Pinus gerardiana*, and *P. wallichiana*. Ashraf et al. (2018) evaluated the impact of climate change on *Capparis spinosa*. The effects of climate change on *B. lycium*, *Mallotus philippensis*, *P. roxburghii*, *P. wallichiana*, *Pistacia integerrima*, *Quercus incana*, *Rhododendron arboreum*, and *Senegalia modesta* were investigated by Ahmad et al. (2020b). Hussain et al. (2024) recorded the soil properties in the areas inhabited by *P. roxburghii*, *P. wallichiana*, *Pyrus pashia,* and *Q. incana* after wildfires. Satti et al. (2024) evaluated the effect of a change in land-use pattern on the antioxidant and phytochemical potential of *Taxus wallichiana*.

Discussion

Our findings suggest that a significant portion of the park's biodiversity remains unexplored, except for insects, amphibians, large mammals, and plants. Data on invertebrates, including many insect orders, as well as fish, reptiles, birds, and small mammals, is lacking. There is a scarcity of data on fish species, despite the park's numerous freshwater streams and rivers (Ahmed et al. 2020, Khatoon et al. 2022). To date, only one study has been published on reptiles, reporting on 15 species (Sajjad et al. 2021). Although four studies are available on bird species (Whistler 1930a, b, Faiz et al. 2017, Zahoor et al. 2022), the research has been limited to the Murree areas, and documentation relies solely on visual encounter methods. Consequently, significant gaps remain in the understanding of the park's avian fauna. Whistler (1930a) first attempted to record the bird species in the Murree Hills area with a record of 97 species, followed by a second record of 34 bird species (Whistler 1930b). Recent documentation on avifauna was carried out by Faiz et al. (2017) and Zahoor et al. (2022). Two bird species reported by Whistler (1930b) are now extinct from the park area, namely the Red-headed Vulture (*Sarcogyps calvus*) (IUCN 2021a) and the White-rumped Vulture (*Gyps bengalensis*) (IUCN 2021b). Apart from carnivores and a few herbivore species, no data is available on other mammals of the park. Rodents, which are considered a serious pest of crops and vegetation (Witmer 2022), have not been the subject of any research study in the park. Similarly, there is no research available on any bat, shrew and primate species. In Ayubia National Park, which is one of the closest parks to Murree-Kotli Sattian-Kahuta National Park, various species of bats, shrews, primates and rodents have been recorded (Shafique & Barkati 2010, Junaid et al. 2023). Likewise, the adjacent Margalla Hills National Park also harbors various species of rodents and the Rhesus Macaque (*Macaca mulatta*) (Fatima et al. 2020, Aslam et al. 2024).

Despite comprehensive documentation of plants in different aspects such as medicinal values, palynological characteristics, and effects of climate change (Mumtaz et al. 2000, Ahmed et al. 2013, Saqib et al. 2014, Ahmad et al. 2018, Ashraf et al. 2018, Ahmad et al. 2020b, Fatimah et al. 2022), several aspects remain unexplored and require investigation. Research on the utilization of plant species for food, fuelwood, fodder, and other human purposes is lacking. This lack of data poses a significant obstacle to the effective conservation and management of the park's flora. Research gaps (Short Duration: study was conducted over a short duration; Limited Sampling: samples were collected from specific parts of the national park; Conventional Methods: advanced and modern techniques were not utilized in the study) in faunistic (Table 1) and floristic (Table 2) studies are provided.

Table 1. Research gaps (Short Duration, Limited Sampling, Conventional Methods) in faunistic studies conducted in Murree-Kotli Sattian-Kahuta National Park.

Source	Gaps		
	Short Duration	Limited Sampling	Conventional Methods
Whistler 1930a	✓	✓	✓
Whistler 1930b	✓	✓	✓
Qureshi 1980	✓	✓	✓
Ahmed et al. 1981	✓	✓	✓
Rahman & Chaudhry 1986	✓	✓	✓
Ahmed 2008	✓	✓	✓
Qasim et al. 2014	✓	✓	✓
Rais 2014	✓	✓	✓
Rais et al. 2014	✓	✓	✓
Irshad et al. 2015		✓	✓
Batool & Hussain 2016	✓	✓	✓
Saadat et al. 2016	✓	✓	✓
Faiz et al. 2017	✓	✓	✓
Shah et al. 2017		✓	✓
Asad et al. 2019	✓	✓	✓
Habiba et al. 2019		✓	✓
Khatoon et al. 2019a		✓	
Khatoon et al. 2019b		✓	
Mahmood et al. 2019		✓	✓
Ahmad et al. 2020a	✓	✓	✓
Ahmed et al. 2020		✓	✓
Gill et al. 2020a	✓	✓	
Gill et al. 2020b		✓	
Habiba et al. 2020		✓	✓
Waseem et al. 2020a	✓	✓	✓
Waseem et al. 2020b	✓	✓	✓
Akram et al. 2021	✓		
Habiba et al. 2021a		✓	✓
Habiba et al. 2021b		✓	✓
Rais et al. 2021			✓
Saeed et al. 2021	✓	✓	
Sajjad et al. 2021		✓	✓
Sarwar et al. 2021		✓	✓
Akram et al. 2022	✓	✓	
Ikram et al. 2022		✓	✓
Khatoon et al. 2022		✓	✓
Saeed et al. 2022a		✓	
Saeed et al. 2022b		✓	
Zahoor et al. 2022		✓	✓
Abbas et al. 2023	✓	✓	✓
Batool et al. 2023	✓	✓	✓
Danish et al. 2023	✓	✓	✓
Rais et al. 2023a			✓
Rais et al. 2023b		✓	
Zahoor et al. 2023		✓	✓

Table 2. Research gaps (Short Duration, Limited Sampling, Conventional Methods) in floristic studies conducted in Murree-Kotli Sattian-Kahuta National Park.

Source	Gaps		
	Short Duration	Limited Sampling	Conventional Methods
Khan & Ahmad 1976	✓	✓	✓
Sheikh & Aleem 1978	✓	✓	✓
Sheikh & Bangash 1985	✓	✓	✓
Hussain 1986	✓	✓	✓
Khattak & Mahmood 1986	✓	✓	✓
Ramnani et al. 1986	✓	✓	✓
Chaudhry & Chaudhry 1992	✓	✓	✓
Mumtaz et al. 2000	✓	✓	✓
Hussain et al. 2004	✓	✓	
Gulfraz et al. 2006	✓	✓	✓
Ahmad et al. 2007	✓	✓	✓
Ahmed et al. 2011	✓	✓	✓
Hussain et al. 2011	✓	✓	✓
Ahmed et al. 2013	✓	✓	✓
Ashraf et al. 2014		✓	✓
Saqib et al. 2014	✓	✓	✓
Shaheen et al. 2014a	✓	✓	✓
Shaheen et al. 2014b	✓	✓	✓
Muhammad & Khan 2016	✓	✓	✓
Ahmad et al. 2018	✓		✓
Ashraf et al. 2018			✓
Khan et al. 2018a	✓	✓	✓
Khan et al. 2018b	✓	✓	✓
Zarif et al. 2018	✓	✓	✓
Ahmed et al. 2019a			✓
Ahmed et al. 2019b			✓
Ahmad et al. 2020b	✓	✓	✓
Iqbal et al. 2020		✓	✓
Javed et al. 2020	✓	✓	✓
Khan et al. 2020a	✓	✓	✓
Khan et al. 2020b	✓	✓	✓
Muhammad et al. 2021a	✓	✓	✓
Muhammad et al. 2021b	✓	✓	✓
Ansari et al. 2022		✓	✓
Asghar et al. 2022		✓	✓
Fatimah et al. 2022	✓	✓	✓
Malik et al. 2023	✓	✓	✓
Naqvi et al. 2023	✓	✓	✓
Hussain et al. 2024	✓	✓	✓
Satti et al. 2024	✓	✓	✓

As this national park provides habitat to some of Pakistan's endemic amphibians (Saeed et al. 2021, Batool et al. 2023), there is a need to investigate whether the amphibian species are impacted by the Chytrid Fungus (*Batrachochytrium dendrobatidis*) in any part of the

park. *Allopaa hazarensis* and *Nanorana vicina,* which inhabit the freshwater streams within the park, may face threats because of presence of plastic in freshwater streams, and road networks inside the park, which may act as barriers to their movement, leading to habitat fragmentation and maybe responsible for road mortality also.

Murree, part of this national park, is also a popular hill resort that attracts more than 1,000 visitors daily (Kausar et al. 2013, Arshad et al. 2018), because of its mountain ranges (Figure 2A), diverse forests (Figure 2B), dense vegetation (Figure 2C), and freshwater streams (Figure 2D). Murree is often recognized as the largest recreational area of the western Himalayan foothills (Kausar et al. 2014). The high volume of tourism in Murree is responsible for increased environmental pollution, which directly threatens the local fauna and flora of the park (Anjum et al. 2024). The native people of the park possess centuries-old knowledge about the utilization of plants. Still, they over-exploit the vegetation resources (Ahmad et al. 2015), which puts additional pressure on the flora. The invasive plant species *Hydrilla verticillata* (Carniatto et al. 2014), *Lantana camara* (Kato-Noguchi & Kurniadie 2021), and *Parthenium hysterophorus* (Adkins & Shabbir 2014) have also been recorded in studies, posing a significant threat to the park's threatened biodiversity (Table 3).

We recommend utilizing advanced technology for research in Murree-Kotli Sattian-Kahuta National Park to enhance the effectiveness of conservation efforts and research. This includes employing advanced tools such as drones for aerial surveys, satellite imagery for monitoring landscape changes, and remote sensing technology for data collection in inaccessible areas. Utilizing eDNA (environmental DNA) for detecting species, especially fish and reptiles, will be important in uncovering hidden biodiversity. Additionally, the well-rounded management of the park should focus on both species conservation and providing a positive experience for tourists. Effective management plans must be implemented to preserve the park's biodiversity while accommodating and educating visitors, ensuring a balance between conservation and tourism.

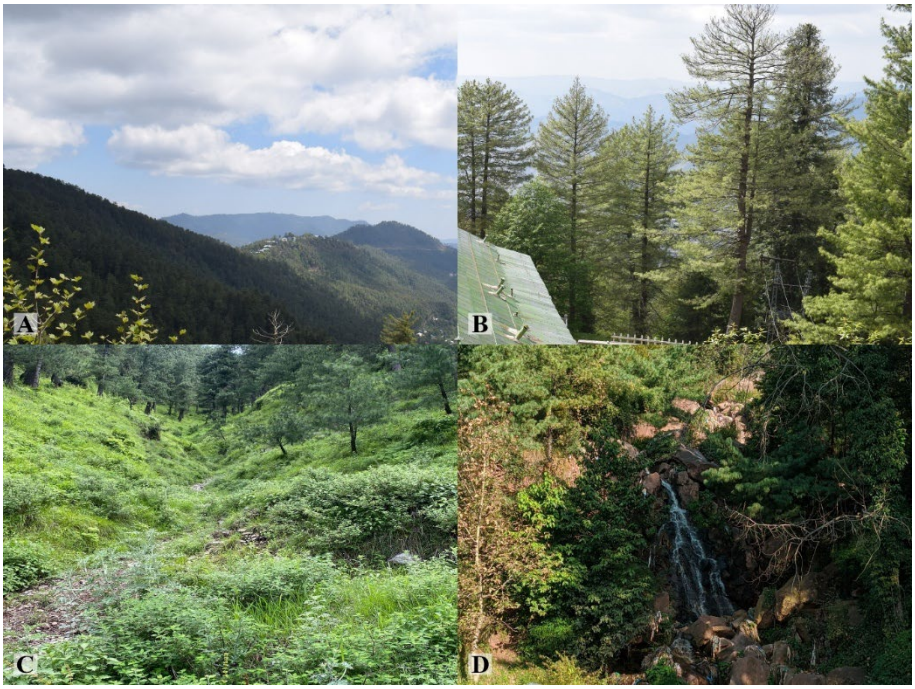

Figure 2. A. Mountains; B. Forest; C. Vegetation; D. A freshwater stream. (Photo Credit: Ahmed Junaid).

Table 3. Threatened biodiversity of Murree-Kotli Sattian-Kahuta National Park, Rawalpindi, Punjab, Pakistan.

Common Name	Scientific Name	Family	Order	IUCN Status	Reference
Indian Flapshell Turtle	*Lissemys punctata*	Trionychidae	Testudines	Vulnerable	Rahman et al. 2021
Indian Softshell Turtle	*Nilssonia gangetica*	Trionychidae	Testudines	Endangered	Ahmed et al. 2021
Bengal Monitor Lizard	*Varanus bengalensis*	Varanidae	Squamata	Near Threatened	Cota et al. 2021
Cheer Pheasant	*Catreus wallichii*	Phasianidae	Galliformes	Vulnerable	Awan et al. 2019
Red-headed Falcon	*Falco chicquera*	Falconidae	Falconiformes	Near Threatened	Lekshmi & Boobalan 2018
Bearded Vulture	*Gypaetus barbatus*	Accipitridae	Accipitriformes	Near Threatened	Paudel et al. 2016
Himalayan Griffon	*Gyps himalayensis*	Accipitridae	Accipitriformes	Near Threatened	Bhusal et al. 2021
Yellow-rumped Honeyguide	*Indicator xanthonotus*	Indicatoridae	Piciformes	Near Threatened	Duan et al. 2018
Egyptian Vulture	*Neophron percnopterus*	Accipitridae	Accipitriformes	Endangered	Cortés-Avizanda et al. 2018
Alexandrine Parakeet	*Palaeornis eupatria*	Psittacidae	Psittaciformes	Near Threatened	Sharma et al. 2022
Indian Pangolin	*Manis crassicaudata*	Manidae	Pholidota	Endangered	Mahmood et al. 2019
Himalayan Goral	*Naemorhedus goral*	Bovidae	Artiodactyla	Near Threatened	Haq et al. 2023
Leopard	*Panthera pardus*	Felidae	Carnivora	Vulnerable	Baral et al. 2023
Atlas Daisy	*Anacyclus pyrethrum*	Asteraceae	Asterales	Vulnerable	Ouarghidi et al. 2017
Safed Musli	*Chlorophytum borivilianum*	Asparagaceae	Asparagales	Critically Endangered	Chauhan et al. 2016
Indian Nard	*Nardostachys jatamansi*	Caprifoliaceae	Dipsacales	Critically Endangered	Chauhan et al. 2021
Atis	*Aconitum heterophyllum*	Ranunculaceae	Ranunculales	Endangered	Mishra et al. 2023
Indian Belladonna	*Atropa acuminata*	Solanaceae	Solanales	Endangered	Khan et al. 2017
Himalayan Gentian	*Gentiana kurroo*	Gentianaceae	Gentianales	Critically Endangered	Skinder et al. 2017
Jivak	*Malaxis muscifera*	Orchidaceae	Asparagales	Vulnerable	Bhardwaj et al. 2017
Indian Bdellium-Tree	*Commiphora wightii*	Burseraceae	Sapindales	Critically Endangered	Mathur et al. 2023
Gerrard's Pine	*Pinus gerardiana*	Pinaceae	Pinales	Near Threatened	Prakash et al. 2023
Ban Oak	*Quercus oblongata*	Fagaceae	Fagales	Near Threatened	Cianfaglione & Bănăduc 2024
East Himalayan Yew	*Taxus wallichiana*	Taxaceae	Pinales	Endangered	Paul et al. 2013
River Red Gum	*Eucalyptus camaldulensis*	Myrtaceae	Myrtales	Near Threatened	Fensham et al. 2019

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