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Distribution, Population Status, and Conservation Challenges of Rhesus Macaques (*Macaca mulatta*) in Machiara National Park, Azad Jammu and Kashmir, Pakistan

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SUMMARY

Rhesus macaque (*Macaca mulatta)* is a widely distributed primate species in South Asia; yet its population dynamics, habitat preferences, and conservation challenges remain understudied in Machiara National Park (MNP), Azad Jammu and Kashmir. Understanding its distribution, feeding ecology, and threats is essential for effective conservation planning. This study aims to assess the population status, habitat utilization, and human-macaque interactions in MNP to provide insights into species conservation. Extensive field surveys were conducted across twenty localities in MNP, ranging from 1329 to 2888 meters above sea level. Population estimates were made through direct counts, and habitat assessment was carried out by recording vegetation composition, water availability, and altitudinal preferences. Feeding behavior was observed to document diet composition, including natural food sources and crop-raiding incidents. Interviews with local communities were conducted to assess human-wildlife conflict and conservation threats. A total of 740 macaques were recorded in twenty troops, with an increasing population trend compared to previous studies, likely due to improved park protection and habitat quality. Macaques preferred temperate forest habitats dominated by *Pinus wallichiana*, *Abies pindrow*, *Picea smithiana*, *Cedrus deodara*, and *Quercus incana*, avoiding alpine and subalpine regions due to predation risks and lack of shelter. Their diet consisted of fruits, leaves, flowers, seeds, and shoots from 35 plant species, supplemented by cultivated crops, especially maize, which was the primary cause of human-macaque conflict. Conservation threats included habitat degradation due to deforestation, illegal hunting, and retaliatory killings by farmers attempting to protect crops. The findings highlight the need for conservation interventions, including habitat restoration, community awareness programs, and conflict mitigation strategies. Strengthening law enforcement against illegal hunting and deforestation, along with promoting non-lethal crop protection techniques, could reduce human-macaque conflict. Further ecological and behavioral research is recommended to develop sustainable conservation strategies for *Macaca mulatta* in MNP.

Keywords: *Macaca mulatta*, Population, Habitat, Machiara National Park.

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INTRODUCTION

The Rhesus monkey (*Macaca mulatta*), an Old World monkey, belongs to the subfamily *Cercopithecinae* and is widely distributed across Asia, including Pakistan, India, China, and beyond (Timmins et al., 2008). It has also been introduced in regions like the U.S., Brazil, and Puerto Rico (Jiang et al., 2008). These primates exhibit sexual dimorphism, with males being larger than females, and they thrive in diverse habitats, from high-altitude forests to semi-deserts (Seth and Seth, 1986; Srivasta and Mohnot, 2001).

In Pakistan, Rhesus monkeys are mainly found in the northern hilly regions, including Murree, Swat, and Azad Jammu and Kashmir (Sheikh and Molur, 2004; GONWFP, 1997). They are omnivorous, feeding on fruits, leaves, insects, and even cultivated crops like maize (Wang, 2001; Hill, 1997). Their feeding habits vary with seasons, as they shift between terrestrial and arboreal feeding (Feeroz, 2012). They are social animals, living in troops of up to 150 members, and have a defined reproductive cycle, with females giving birth once a year after a 160-day gestation period (Jiang et al., 2008; Hou et al., 1998; Jahangeer et al., 2024).

Globally, Rhesus macaques are classified as "Least Concern," but their populations in Pakistan face threats due to habitat destruction, deforestation, and human-wildlife conflict, especially as they raid crops (Timmins et al., 2008; Gosh, 2009; Jahangeer et al., 2024). They are also used in biomedical research and sometimes captured for entertainment purposes (Southwick and Siddiqi, 1994a; GONWFP, 1997). Historically, excessive trapping in India led to a severe population decline, prompting conservation efforts (Southwick and Siddiqui, 1994b).

Rhesus monkeys play a crucial ecological role by aiding seed dispersal, serving as prey for predators, and reducing waste by consuming discarded fruits and vegetables (Goldstein and Richard, 1989; Richard et al., 1989). They are also significant in medical research, contributing to studies on human diseases, vaccine development, and genetics (Stewart and Disotell, 1998; Page and Goodman, 2001; Kumar and Chopra, 2012). Despite their ecological and scientific importance, their conservation status in Pakistan, particularly in Azad Jammu and Kashmir, remains poorly studied, highlighting the need for further research in Machiara National Park (Minhas, 2008).

Machiara National Park (MNP) is a critical habitat for rhesus macaques, providing them with essential forest resources. However, anthropogenic pressures such as deforestation and livestock grazing pose significant challenges to their survival (Qamar and Minhas, 2006). This study aims to investigate the distribution, population density, habitat preferences, and conservation challenges of rhesus macaques in MNP.

MATERIALS AND METHODS

STUDY AREA

Machiara National Park (MNP), located in Azad Jammu and Kashmir (AJK) at 34º-31’ N latitude and 73º-37’ E longitude, spans 135.32 km² (33,437 acres) with an altitude range of 1,300 m to 4,733 m above sea level. It lies 32 km from Muzaffarabad and experiences a temperature range of -2°C to 46°C (Minhas et al., 2010). The park includes three Union Councils Bheri, Machiara, and Serli Sacha

comprising 30 villages, 7,635 households, and a population of 52,000 (Awan et al., 2004; Qamar and Minhas, 2006). Due to poverty and lack of alternative resources, local communities depend on the park for timber, fuelwood, and livestock grazing, with 37,000 livestock reported in the area (Qamar et al., 2008). MNP has a temperate Himalayan climate influenced by the southwest monsoon, featuring severe winters, summer rains, and dry autumns (Awan et al., 2004; Jahangeer et al., 2019). It hosts diverse ecosystems, including Himalayan temperate mixed forests and alpine scrub, supporting rich flora and fauna. The dominant vegetation includes conifers like *Taxus wallichiana*, *Cedrus deodara*, *Picea smithiana*, *Pinus wallichiana*, and *Abies pindrow*, along with broad-leaved species such as *Aesculus indica* and *Prunus cornutus* (Qamar et al., 2008). The park is home to several threatened wildlife species, including the Snow leopard (*Uncia uncia*), Musk deer (*Moschus chrysogaster*), Western horned tragopan (*Tragopan melanocephalus*), Himalayan Griffon vulture (*Gyps himalayensis*), Himalayan grey langur (*Semnopithecus ajax*), and the Cheer pheasant (*Catreus wallichii*) (Minhas et al., 2010; Altaf and Umair, 2022).

DATA COLLECTION

Survey was conducted in Machiara National Park (MNP) from May to December 2020 to assess the distribution, population status, habitat, and food utilization of the Rhesus monkey.

Distribution Assessment

Information on the monkey's distribution was initially gathered through informal interviews with park staff, herders, and villagers. Field surveys included 20 transect walks (1-6 km each) covering 46 km² of potential habitats (Figure 1). Observations were made for direct sightings and indirect signs (fecal pellets, footprints, hair, etc.), and locations were recorded using a GPS device (Hasan et al., 2013) (Table 1).

Population Census

Visual counts were conducted along 120 km of transects, with an average of 12 km surveyed per day. Individual identification was based on distinguishing features such as injuries or missing digits to prevent double counting (Imam and Ahmad, 2013). Group size, age, and sex composition were documented (Figure 1).

Habitat and Food Assessment

Every 600 meters, vegetation data (dominant trees, shrubs, herbs) were recorded within a 100 m radius. Additional habitat factors such as land use, topography, and aspect were noted. Feeding behavior was monitored using focal and scan sampling techniques, and plant species consumed were identified. Signs of feeding, such as partially eaten plants, were examined, and interviews with locals supplemented the findings (Chhangani and Mohnot, 2004).

Conservation Status

Field observations recorded land use, grazing intensity, logging, and human encroachments. Interviews with locals helped gather additional insights into the conservation status of macaques (Chetry et al., 2008).

Table 1: Detail of transects laid during surveys of Rhesus monkey in Machiara National Park in 2020.

S#	Transect #	Forest Co. #	localities	Locations	Area surveyed (km^2)
1	1	7	Pakhlan	N 34°26. 764 E 73°33. 184	2
2	2		Gran Kotli	N 34°26. 862 E 73°41. 304	3
3	3	8	Mohri	N 34°33. 960 E 73°35. 312	2
4	4		Biarian	N 34°33. 608 E 73°34. 700	2
5	5		Shah Khori	N 34°33. 402 E 73°33. 615	3
6	6	9	Magri	N 34°32. 321 E 73°55. 581	1.5
7	7		Gali (Sar)	N 34°32. 500 E 73°34. 487	3
8	8		Gatti	N 34°55. 059 E 73°59. 417	2
9	9		Jabra	N 34°29. 900 E 73°37. 729	2.5
10	10		Tahara	N 34°31. 719 E 73°37. 026	2
11	11		Kundi	N 34°53. 896 E 73°60. 000	2
12	12		Dagri	N 34°52. 201 E 73°60. 260	3
13	13		Thora	N 34°32. 398 E 73°33. 396	1.5
14	14		Kaian	N 34°52. 367 E 73°61. 870	2
15	15		Bognari Katha	N 34°49. 940 E 73°65. 134	3
16	16	11	Chiri Tohora	N 34°29. 791 E 73°38. 542	3
17	17	13	Boban Baila	N 34°29. 603 E 73°42. 583	1.5
18	18		Banrh	N 34°29. 381 E 73°42. 770	2
19	19		Seri-Pathra	N 34°29. 849 E 73°43. 049	2
20	20	15	Jugian	N 34°29. 687 E 73°37. 322	3

Figure 1: Direct sighting of Rhesus macaques at different sites in study area during 2020 visits.

RESULTS

DISTRIBUTION

Rhesus macaques (*Macaca mulatta*) were widely distributed across all three union councils of Machiara National Park (MNP). A total of 20 different localities were identified within the 46 km² study area, with an elevation range between 1329 and 2888 meters above sea level. The highest recorded elevation for rhesus macaques was

in Mohri (2888 m), whereas the lowest was in Gran Kotli (1329 m). The monkeys were frequently observed in forested areas, preferring habitats with dense vegetation and water availability (Table 2; Figure 2).

Table 2: Distribution of *Macaca mulatta* in Machiara National Park during year, 2020.

Sr.	Groups Name	Forest Compartment	Union councils	Localities	Locations	Elevation (m)
1	A	7	Bheri	Pakhlan	N 34°26. 764 E 73°33. 184	1560
2	B			Gran Kotli	N 34°26. 862 E 73°41. 304	1329
3	C	8		Mohri	N 34°33. 960 E 73°35. 312	2888
4	D			Biarian	N 34°33. 608 E 73°34. 700	2300
5	E			Shah Khori	N 34°33. 402 E 73°33. 615	2436
6	F	9		Magri	N 34°32. 321 E 73°55. 581	2490
7	G			Gali (Sar)	N 34°32. 500 E 73°34. 487	1995
8	H			Gatti	N 34°55. 059 E 73°59. 417	2106
9	I			Jabra	N 34°29. 900 E 73°37. 729	2445
10	J		Machiara	Tahara	N 34°31. 719 E 73°37. 026	2355
11	K			Kundi	N 34°53. 896 E 73°60. 000	2512
12	L			Dagri	N 34°52. 201 E 73°60. 260	2355
13	M			Thora	N 34°32. 398 E 73°33. 396	2882
14	N		Sarli Sacha	Kaian	N 34°52. 367 E 73°61. 870	2580
15	O			Bognari Katha	N 34°49. 940 E 73°65. 134	2033
16	P	11		Chiri Tohora	N 34°29. 791 E 73°38. 542	2424
17	Q	13		Boban Baila	N 34°29. 603 E 73°42. 583	2355
18	R			Banrh	N 34°29. 381 E 73°42. 770	2514
19	S			Seri-Pathra	N 34°29. 849 E 73°43. 049	2690
20	T	15		Jugian	N 34°29. 687 E 73°37. 322	1851

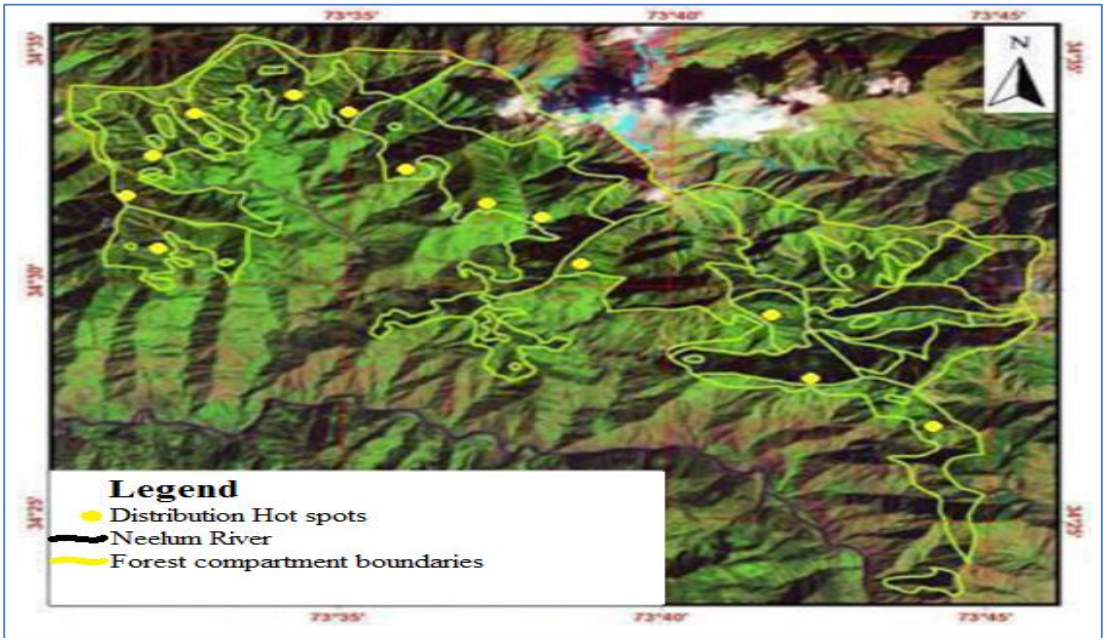

Figure 2: Map of MNP with distribution of macaques at different localities during 2020.

POPULATION STATUS

During the study period, 20 distinct troops of rhesus macaques were recorded, comprising a total of 740 individuals. The overall population density was 16 animals/km². The highest population density (18.66 animals/km²) was observed in Jugian (Forest Compartment #15) with 56 individuals, whereas the lowest population density (8 animals/km²) was recorded in Bognari Katha. The average group size was 37 individuals, ranging from 22 to 56 members per troop (Table 3).

Table 3: Population density of *Macaca mulatta* found at different localities of the MNP.

Sr.	Groups Name	Localities	Infants	Juveniles	Adults		Total population	Area surveyed (km^2)	Population Density (Km^2)
					Male	female			
1	A	Pakhlan	5	3	10	30	48	4	12
2	B	Gran Kotli	6	3	7	22	38	2	19
3	C	Mohri	7	4	9	20	40	2	20
4	D	Biarian	2	2	5	21	30	2	15
5	E	Shah Khori	8	4	7	24	43	3	14.33
6	F	Magri	3	2	4	13	22	1.5	14.66
7	G	Gali (Sar)	9	3	6	19	37	3	12.33
8	H	Gatti	6	2	5	18	29	2	14.5
9	I	Jabra	7	5	9	21	52	2.5	20.8
10	J	Tahara	4	4	7	17	32	2	16
11	K	Kundi	5	2	8	26	41	2	20.5
12	L	Dagri	4	3	7	25	39	3	13
13	M	Thora	5	2	6	22	35	1.5	23.33
14	N	Kaian	7	3	5	29	43	2	21.5
15	O	Bognari Katha	3	4	3	15	24	3	8
16	P	Chiri Tohora	5	3	4	19	31	2	15.5
17	Q	Boban Baila	6	2	6	22	36	1.5	24
18	R	Banrh	3	2	5	18	28	2	14
19	S	Seri-Pathra	5	3	9	19	36	2	18
20	T	Jugian	11	5	13	33	56	3	18.66
		Total	**111**	**61**	**135**	**433**	**740**	**46**	**16**
					Mean group size = 37				

HABITAT PREFERENCES

Rhesus macaques in MNP were primarily found in moist temperate, mixed coniferous, and dry temperate mixed forests. The species demonstrated a strong preference for moist temperate forests, which provided protection from predators and extreme weather conditions. A general assessment of vegetation across macaque habitats revealed dominant tree species, including *Pinus wallichiana, Abies pindrow, Picea smithiana, Cedrus deodara, and Quercus incana.* *Among shrubs, Vibernum nervosum, Indigofera heterantha, Berberis aristidae, Betula utilis, and Juniperus communis* were prevalent. The herbaceous layer was dominated by *Bergenia stracheyi, Impatiens edgeworthii, Rumex nepalensis, Polygonum amplexicaule, and Artemisia spp.* (Figure 3 and Table 4).

Figure 3: Landscapes of study areas.

Table 4: Comparison of habitat type and vegetation of different study localities of the study area during 2020.

Sr.	Localities	Important Vegetation	Topography/ Habitat type
1	Pakhlan	*Bergenia ciliate, Betula utilis, Cedrus Deodara, Cymbopogan martini, Indigofera heterantha, Picea smithiana, Pinus wallichiana, Polygonum amplexicaule, Quercus incana, Taxus wallichiana, Vibernum nervosum,*	Rocky boulder with strew slopes with ground vegetation
2	Gran Kotli	*Bergenia stracheyi, Cymbopogan martini, Euphorbia* spp. *Juniperus communis, Pinus wallichiana, Podophyllum emodi, Quercus incana, Taxus wallichiana, Vibernum nervosum,*	
3	Mohri	*Abies Pindrow, Bergenia ciliate, Euphorbia* spp. *Geranium wallichianum, Indigofera heterantha, Pinus wallichiana,*	Moist temperate forest with steep slopes and dense ground vegetation
4	Biarian	*Aconitum heterophyllum, Aesculus indica, Berbri saristidae, Malva* spp., *Poa annua, Prunnus cornuta, Salix denticulate, Thymus serpyllum, Vibernum nervosum, Vitis vinifera,*	
5	Shah Khori	*Aesculus indica, Bistorta* spp. *Poa annua, Prunnus cornuta, Rhodendron hypenanthum, Rumex nepalensis, Salix denticulate, Thymus serpyllum, Urtic adioica, Viburnum erubeseens, Viscum album*	
6	Magri	*Prunnus cornuta, Qurcus incana, Aesculus indica, Juniper communis, Poa annua, Vitis vinifera, Viscum album, Vibernum* spp. *Salix denticulate*	Moist temperate mixed coniferous forest, subalpine scrubs
7	Gali (Sar)	*Viola* spp. *Salix denticulate, Prunnus cornuta, Aesculus indica, Thymus serpyllum, Polygonum amplexicaulis, Viscum album,*	
8	Gatti	*Cedrus deodara, Qurcus incana Salix denticulate, Prunnus cornuta Aesculus indica, Poa annua, Malva* spp. *Vitis vinifera, Abies pindrow, Vibernum* spp.	
9	Jabra	*Viburnum erubeseens, Salix denticulate, Malva* spp., *Aesculus indica, Juglans regia, Poa annua,*	
10	Tahara	*Juglans regia, Arundo donax , Poa annua, Cedrus deodara, Aesculus indica, Celtis australis, Rhodendron hypenanthum, Adiantum incisum, Thymus serpyllum*	
11	Kundi	*Betula utilis, Vibernum nervosum, Juglans regia, Celtis australis, Poa annua, Viscum album, Viburnum erubeseens,*	
12	Dagri	*Viburnum erubeseens, Bistorta* spp. *Abies pindrow, Juglans regia, Poa annua, Adiantum incisum, Arundo donax, Viscum album*	

13	Thora	*Juglans regia, Vibernum nervosum, Cedrus deodara, Taxus wallichiana, Poa annua, Thymus serpyllum, Adiantum incisum*	
14	Kaian	*Pinus wallichiana ,Quercus incana, Cedrus deodara, Viburnum erubeseens, Bergenia ciliate, Adiantum incisum, Thymus serpyllum*	
15	Bognari Katha	*Vibernum nervosum, Senecio* spp. *Thymus serpyllum, Viscum album, Cedrus deodara, Betula utilis, Polygonum amplexicaulis, Rhodendron hypenanthum*	
16	Chiri Tohora	*Adiantum incisum, Bistorta* spp. *Polygonum amplexicaulis, Vitisvinifera, Viscum album, Prunnus cornuta , Viburnum erubeseens,Viola* spp. *Viburnum*	Open rocky slopes covered with dense grass
17	Boban Baila	*Berbaris, Indegofera* and *Vibernum* spp. *Prunnus cornuta, Juglans regia, Salix denticulate, Rhodendron hypenanthum, Viscum album, Polygonum amplexicaulis*	Moist temperate with strewn sloppy Rocky with steep gorges
18	Banrh	*Prunnuscornuta, Juglans regia, Berbaris, Indegofera and Vibernum* spp. *Bistorta* spp. *Rumex nepalensis, Vitis vinifera, Adiantum incisum, Polygonum amplexicaulis*	
19	Seri Pathra	*Viburnum erubeseens, Indegofera, Vibernum* spp. *Polygonum amplexicaulis, Malva* spp. *Prunnus cornuta, Juglans regia, Salix denticulate, Adiantum incisum, Vitis vinifera*	
20	Jugian	*Juniperus communis, Indigofera heterantha, Abies pindrow, Pinus wallichiana, Vitis vinifera, Bergenia stracheyi, Malva* spp., *Salix denticulate, Impatiens edgeworthii, Adiantum incisum, Thymus serpyllum*	Moist temperate with strew slopes

FOOD UTILIZATION

Rhesus macaques were observed consuming various plant species, indicating their frugivorous and folivorous dietary habits. The study recorded the consumption of 35 plant species, including trees, shrubs, and herbs. The monkeys fed on different plant parts, such as fruits, leaves, flowers, seeds, shoots, and buds (Table 5). In addition to wild plant resources, macaques were also found foraging on cultivated crops and vegetables, often entering human settlements in search of food. This opportunistic feeding behavior sometimes led to conflicts with local farmers.

Table 5: Names of the plants and their parts consumed the focal individuals of the macaques during.

Sr.	No. of plants	Local name	Type	Parts consumed
1	*Abies pindrow*	Rewar	Tree	Shoots
2	*Pinus wallichiana*	Kail	Tree	Seed
3	*Taxus wallichiana*	Bermi	Tree	Leaves
4	*Celtis australis*	Batkararh	Tree	Leaves
5	*Cedrus deodara*	Diar	Tree	Leaves, Seed
6	*Aesculus indica*	Bankhor	Tree	Buds, Flowers
7	*Prunus cornuta*	Parthe	Tree	Fruit
8	*Quercus incana*	Reeh	Tree	Leaves
9	*Grewia tenax*	Daminar	Tree	Fruit
10	*Diospyros lotus*	Amaloq	Tree	Fruit, Buds
11	*Indigofera heterantha*	Kainthe	Shrub	Fruit, Buds
12	*Vitis vinifera*	Dahak	Shrub	Fruit

13	*Vibernum nervosum*	Guch	Shrub	Fruit
14	*Betula utilis*	Burzz	Shrub	Leaves
15	*Ribes alpestre*	Kagdak	Shrub	Fruit
16	*Elaeagnus* spp.	Kanqoli	Shrub	Fruit
17	*Rosa burnonii*	Kuruch	Shrub	Fruit
18	*Skimmia laureola*	Nira	Shrub	Shoot
19	*Juniperus communis*	Metheri	Shrub	Bud
20	*Rosa moschata*	Garacha	Shrub	Seed
21	*Berbris aristidae*	Sunbal	Shrub	Flowers, Fruit
22	*Solanum tuberosum*	Aloo	Herbs	Stem, Shoots
23	*Solanum melangena*	Bangun	Herbs	Fruit, Leaves
24	*Zea mays*	Maki	Herbs	Fruit
25	*Polygonum alpinum*	Chukroon	Herbs	Flowers
26	*Asphodelus tenuifolius*	Jangli piaz	Herbs	Flowers
27	*Malva* spp.	Sonchal	Herbs	Fruit
28	*Impatiens edgeworthii*	Bantil	Herbs	Fruit, Shoots
29	*Euphorbia* spp.	Hervi	Herbs	Fruit
30	*Solanum nigrum*	Kachmch	Herbs	Fruit
31	*Bistorta* spp.	Maslonrh	Herbs	Flowers
32	*Plantago major*	ChamchiPattar	Herbs	Seed
33	*Fragaria nubicola*	Meva	Herbs	Fruit
34	*Phaseolus aconitifolius*	Moth	Herbs	Fruit
35	*Musa paradisiacal*	Kaila	Herbs	Fruit

WATER RESOURCES AND DISTRIBUTION

MNP has abundant water resources, including springs, streams (nallas), and small ponds, which serve as vital sources of hydration for wildlife. Macaques were mostly recorded near forested areas, but occasionally they were observed sharing water resources with humans in union councils Bheri, Sarli Sacha, and Machiara.

OTHER RECORDED WILDLIFE SPECIES IN MNP

The study area supports **a** rich diversity of wildlife, with several threatened species coexisting with rhesus macaques. Some of the notable mammals and birds recorded in the study area include, Black bear (*Ursus thibetanus*), Grey Langur (*Semnopithecus ajax*), Common Leopard (*Panthera pardus*), Musk Deer (*Moschus chrysogaster*), Kaleej Pheasant (*Lophura leucomelanos*), Koklass Pheasant (*Pucrasia macrolopha*), Himalayan Monal (*Lophophorus impejanus*), Western Tragopan (*Tragopan melanocephalus*) and Chukar Partridge (*Alectoris chukar*).

CONSERVATION CONCERNS AND THREATS

Although the population of rhesus macaques in MNP appears stable, several anthropogenic threats were recorded during field surveys. One of the major threats to rhesus macaques in MNP is crop raiding, which has led to increasing human-wildlife conflict. Monkeys frequently damage mustard **(***Brassica campestris***),** maize (*Zea mays***),** potatoes (*Solanum tuberosum***)**, brinjal **(***Solanum melongena***),** and fruit trees. In retaliation, farmers use guard dogs to deter macaques, resulting in the reported deaths of 8-10 macaques annually due to dog attacks, while 15-20 individuals are killed by farmers each year. Unfortunately, these incidents are not officially reported to the wildlife department. Habitat degradation was observed as a significant concern due to multiple human activities. Seasonal Movements, during severe winter months,

heavy snowfall forces macaques to move to lower elevations near human settlements, increasing the likelihood of conflicts with local communities. The combination of food scarcity and human activity further exacerbates the threats faced by the species.

DISCUSSION

Rhesus macaques were found in twenty different locations across three union councils in Machiara National Park (MNP), ranging from 1329 to 2888 meters above sea level. They primarily inhabit forested regions and avoid higher elevations due to a lack of shelter and threats from predators like the common leopard (*Panthera pardus*). Additionally, macaques refrain from venturing into open meadows due to avian predation on their infants. While they typically prefer areas near human settlements, they are often deterred by local farmers who perceive them as crop raiders (Seth et al., 2001). Studies in India have shown similar distribution patterns, where macaques migrate to lower altitudes in search of food during winter (Seth et al., 2001).

Past studies in MNP by Minhas (2008) and Baig (2004) reported similar localities of macaque distribution, which aligns with the current findings. Additionally, research in Azad Jammu and Kashmir has documented macaque populations in Moji and Qazinag Game Reserves, which share ecological similarities with MNP (Baig, 2004; Iftikhar, 2006). Sheikh and Molur (2004) also documented macaque distribution in other hilly areas of Pakistan, such as Murree, Swat, Kaghan, Chitral, and Margalla Hills, reinforcing the current study's findings. However, Wolfe (1992) noted that in some regions, macaques coexist with humans, a scenario not observed in MNP, where they are actively deterred by locals.

A total of 740 macaques were recorded in twenty different troops. The protection status of the park, abundant vegetation, and food availability have contributed to a population increase of 104 individuals since the last study by Minhas (2008). However, Baig (2004) estimated a population of 3500 macaques in MNP, a figure that appears inaccurate due to a lack of proper field surveys and reliance on secondary data. Seasonal fluctuations may contribute to variations in macaque populations, as also noted by Baig (2004). Previous estimates by Sheikh and Molur (2004) and Minhas (2008), which reported populations of 500 and 635 individuals, respectively, align closely with the findings of this study, indicating a consistent upward trend in macaque numbers in MNP.

Rhesus macaques in MNP exhibit frugivorous and folivorous feeding habits, consuming various plant parts, including fruits, leaves, flowers, seeds, shoots, and buds, from 35 different plant species. Although they primarily rely on natural vegetation, they opportunistically raid cultivated crops, leading to human-wildlife conflict. Maize (*Zea mays*) was the most frequently raided crop, consistent with findings by Hill (1997).

Several studies have documented the omnivorous diet of Rhesus macaques. Lindburg (1971) observed that their diet includes eggs, termites, and fungi. Imam et al. (2002) and Wolfe (2002) reported their preference for fruits, flowers, leaves, seeds, and bark, while Wolfe (1992) noted their reliance on human-provided food, including bread, bananas, peanuts, and ice cream. The macaques in MNP primarily inhabit moist and dry temperate mixed forests dominated by *Pinus wallichiana*, *Abies*

pindrow, Picea smithiana, Cedrus deodara, and *Quercus incana*. Shrubs such as *Viburnum nervosum, Indigofera heterantha*, and *Berberis aristata* and herbs like *Bergenia stracheyi* and *Rumex nepalensis* were also commonly found. Similar habitat utilization patterns have been reported in previous studies (Minhas, 2008; Goldstein and Richard, 1989).

Water availability is abundant in MNP due to its location within the Neelum River catchment area, ensuring year-round access to water from springs, gullies, and ponds. In summer, macaques rely on melting snow, while in winter, they depend on natural springs and streams.

Despite a stable population, Rhesus macaques face multiple human-induced threats in MNP. Local communities, reliant on park resources due to economic hardship, engage in fodder collection, timber extraction, and cattle grazing, all of which degrade macaque habitat. Additionally, direct hunting, particularly during the crop season, poses a significant threat. Qamar et al. (2008) also noted the adverse impact of socioeconomic dependence on MNP's wildlife. Ahmed et al. (1999) reported similar findings, highlighting habitat loss, trapping, and human-wildlife conflict as major threats to wildlife in Azad Jammu and Kashmir.

Previous studies in Pakistan have emphasized habitat degradation as a critical factor in macaque population decline (Goldstein and Richard, 1989; GONWFP, 1997). In India, urbanization and human settlements have similarly led to habitat destruction and an increase in human-macaque conflicts (Mitra, 2000; Ghosh, 2009). The frequent raiding of crops by macaques has resulted in negative perceptions among local farmers, further exacerbating conservation challenges.

CONCLUSION

This study provides valuable insights into the distribution, population status, feeding ecology, and conservation challenges of *Macaca mulatta* in Machiara National Park. The species was found between 1329 and 2888 meters above sea level, preferring forested habitats while avoiding alpine regions due to limited shelter and high predation risks. The population has shown an increasing trend, likely due to park protection, rich vegetation, and food availability. However, human-macaque conflicts are a significant concern, primarily driven by crop raiding, habitat degradation, and retaliatory killings by local farmers. Encroachments, illegal hunting, and excessive resource extraction further threaten the species and its habitat. Effective conservation measures, such as community-based awareness programs, strict law enforcement, and sustainable livelihood initiatives, are essential to mitigate these threats. Strengthening habitat protection, reducing human-wildlife conflict, and conducting further ecological studies will contribute to the long-term conservation of *Macaca mulatta* in the region.

REFERENCES

Ahmed, K. B., M. S. Awan and M. Anwar. 1999. Status of major wildlife species in Moji game reserve Leepa valley Azad Kashmir. Proceedings of the Pakistan Congress of Zoology 19: 173-182.

Altaf, M., Umair, M., 2022. Ecology of Mountain Ranges in Pakistan-a review. Journal of Wildlife and Ecology 6: 141-149.

Awan, M. S., R. A. Minhas, K. B. Ahmad and N. I. Dar. 2004. Distribution, food and habitat preferences of small mammals in Machiara National Park, District Muzaffarabad, Azad Kashmir, Pakistan. Punjab University Journal of Zoology 19: 17-31.

Baig, K. J. 2004. Progress report, Compilation of baseline data for zoological and wildlife studies in Machiara National Park. Protected Areas Management Project 78.

Burnham, K. P., D. R. Anderson and J. L. Laake. 1980. Estimate of density from line transect sampling of biological populations. Wildlife Monographs 72. Washington, D.C. The Wildlife Society. 202.

Chetry, D., R. Chetry, A. Das, C. Loma and J. Panor. 2008. New distribution records for *Hoolock leuconedys* in India. Primate Conservation 23: 125–128.

Chetry, R. and D. Chetry. 2012. Study on home range of Rhesus monkey, *Macaca mulatta* (Zimmermann, 1758) in Saraswati Plantation Wildlife Sanctuary (SPWS) Kurukshetra, Haryana (India). New York Science Journal 5(1): 6-12.

Chhangani, A. K. and S. M. Mohnot. 2004. Crop raid by Hanuman Langur *Semnopithecus entellus* in and around Aravallis, India and its management. Primate Report 69: 35-47.

Crockett, C. M., R. C. Kyes and D. Sajuthi. 1996. Modeling managed monkey populations: Sustainable harvest of long-tailed macaques on a natural habitat island. American Journal of Primatology 40: 343-360.

De Valois, R. L. 1960. Color vision mechanisms in the monkey. Journal of General Physiology 43(6): 115-128.

Feeroz, M. M. 2012. Niche separation between sympatric Pig-Tailed Macaque (*Macaca leonina*) and Rhesus Macaque (*Macaca mulatta*) in Bangladesh. Journal of Primatology 1: 106.

Feinberg, M. B. and J. P. Moore. 2002. AIDS vaccine models: challenging challenge viruses. Nature Medicine 8: 207–210.

Gause, G. F. 1934. The struggle for existence. Williams and Wilkins Co., Baltimore, USA.

Ghosh, S. 2009. Report on the distribution and population status of the golden langur (*Trachypithecus geei*) in Bodoland Territorial Council Assam, India. 1-44.

Goldstein, S. J. and A. F. Richard. 1989. Ecology of Rhesus macaques (*Macaca mulatta*) in northwest Pakistan. International Journal of Primatology 10(6): 531-567.

GONWFP. 1997. Distribution and status of wildlife in NWFP. North West Frontier Province Wildlife Department

Hasan, M. K., M. A. Aziz, S. M. R. Alam, Y. Kawamoto, L. J. Enge, R. C. Kyes, S. Akhtar, S. Begum and M. M. Feeroz. 2013. Distribution of Rhesus Macaques (*Macaca mulatta*) in Bangladesh: Inter-population variation in group size and composition. Primate Conservation 26: 125–132.

Hill, C. M. 1997. Crop-raiding by wild vertebrates: The farmer's perspective in an agricultural community in Western Uganda. International Journal of Pest Management 43(1): 77-84.

Hou, J. H., W. Y. Zhai, L. Chen and H. X. Zhang. 1998. Study on the reproductive behaviors of Rhesus monkey in Taihang Mountain. Chinese Journal of Ecology 17(4): 22-25.

Imam, E. and A. Ahmad. 2013. Population status of Rhesus monkey (*Macaca mulatta*) and their menace: A threat for future conservation. International Journal of Environmental Science 3(4): 1279-1283.

Imam, E., H. S. A. Yahya and I. Malik. 2002. A successful mass translocation of commensal Rhesus monkeys *Macaca mulatta* in Vrindaban, India. Oryx 36(1): 87-93.

Jahangeer, M., and M.S. Awan. 2024. Distribution of common leopard (*Panthera pardus*) and human-common leopard conflict in Lachhrat Forest Range, Azad Jammu and Kashmir, Pakistan. Journal of Wildlife and Ecology, 8(1): 43–73.

Jahangeer, M., M.S. Awan, M. Altaf, R.A. Minhas, and U. Ali. 2024. Study of bird diversity in Ghamot National Park, Azad Jammu and Kashmir, Pakistan. Pakistan Journal of Zoology 56(1): 61–71.

Jahangeer, M., R.A. Minhas, and S. Awan. 2019. Current distribution and status of Himalayan Grey Langur (*Semnopithecus ajax*) in Lachhrat Forest Range, Azad Jammu and Kashmir, Pakistan. Journal of Wildlife and Ecology, 3(1): 10–20.

Janson, C. H. and L. H. Emmons. 1990. Ecological structure of the non-flying mammal community at Cocha Cashu Biological Station, Manu National Park, Peru. Four Neotropical Forests 314-338.

Jiang, Z. G. 2005. Biodiversity of the Qingmuchuan Nature Reserve, Shaanxi Province. Tsinghua University Press, Beijing.

Jiang, Z., Z. Meng, Y. Zeng, Z. Wu and Z. Zhou. 2008. CITES non-detrimental finding for exporting Rhesus Monkey (*Macaca mulatta*) from China. NDF Workshop Case Studies.

Kumar, A. and G. Chopra. 2012. Study on home range of Rhesus monkey, *Macaca mulatta* (Zimmermann, 1758) in Saraswati Plantation Wildlife Sanctuary (SPWS) Kurukshetra, Haryana (India). New York Science Journal 5(1): 6-12.

Lambert, J. E. 2012. Primates in communities: The ecology of competitive, predatory, parasitic, and mutualistic interactions between primates and other species. Nature Education Knowledge 3(10): 85.

Lang, K. C. 2005. Primate Factsheets: Rhesus macaque (*Macaca mulatta*) taxonomy, morphology and ecology. Accessed 2015 April 10.

Lindburg, D. G. 1971. The Rhesus monkey in north India. An ecological and behavioral study. In: L. A. Rosenblum (ed.), Primate Behavior. Academic Press, New York 2(9): 1-106.

Minhas, R. A., M. S. Awan, N. I. Dar and K. B. Ahmed. 2010. Social organization and reproductive biology of Himalayan grey langur (*Semnopithecus ajax*) in Machiara National Park, Azad Jammu and Kashmir, Pakistan. Pakistan Journal of Zoology 42(3): 267-283.

Nowak, R. M. 1999. Walker's Primates of the World. The Johns Hopkins University Press, Baltimore.

Rawson, B. M., R. Roos and C. Roos. 2011. The taxonomy of crested gibbons. In: The Gibbons: New Perspectives on Small Ape Socioecology and Population Biology. Springer, New York.

Richard, A. F. 1985. Primates in Nature. W. H. Freeman and Company, New York.

Singh, M., A. Krishna Balaji, A. S. Kumar, M. K. Singh, A. Kumara and H. S. Sushma. 2001. Population and conservation status of the lion-tailed macaque Macaca silenus in the Western Ghats, South India. Current Science 80(3): 348-354.

Southwick, C. H., M. F. Siddiqi and A. F. Seth. 1996. Crop raiding by Rhesus troops in India: Patterns of troop movement and field damage. International Journal of Pest Management 42(2): 157-164.

Srivastava, A. and S. M. Mohmot. 2001. Distribution, conservation status and priorities for primates in northern India. Wildlife and Protected Areas Dehradun (India): Wildlife Institute India 102-108.

Timmins, R. J., M. Richardson, A. Chhangani and L. Yongcheng. 2008. *Macaca mulatta*. The IUCN Red List of Threatened Species. Version 2014.3.

Tiwari, K. K. and R. P. Mukherjee. 1992. Population census of Rhesus macaques and Hanuman langurs in India. Records of the Zoological Survey of India 92(1-4): 349-369.

Wang, D. S. 2001. Present state and conservation of Rhesus monkeys in Panzhihua City. Science and Technology Information of Panzhihua 26(1): 27-29.

Wolf, L. D. 1992. Feeding habitats of Rhesus macaques (*Macaca mulatta*) of Jaipur and Gulta. Journal of Experimental Zoology 7(4): 43-54.

Wolf, L. D. 2002. Rhesus macaque: A comprehensive study of two sites, Jaipur in India and Silver Springs, Florida. Cambridge (U.K.), Cambridge University Press 7(2): 310-330.

Wolfheim, J. H. 1983. Primates of the World: Distribution, Abundance, and Conservation. University of Washington Press, Seattle, WA.

Wrangham, R. W. 1980. An ecological model of female-bonded primate group. Behaviour 75: 261-300.

Wrangham, R. W. 1987. The evolution of social structure. In: B. B. Smuts, D. L. Cheney, R. M. Seyfarth, R. W. Wrangham and T. T. Struhsaker (Eds.), Primate Societies. University of Chicago Press 282-296

WWF GIS Laboratory Pakistan. 2008. Boundary delineation of Machiara National Park 1-44.

Zheng, S. W., H. Zuo and H. H. Xu. 1994. Survey on the Rhesus monkey resource of Nanzheng in Shaanxi Province. Sichuan Journal of Zoology 13: 26-27.

Zhou, F. G. and Z. P. Yu. 1996. Artificial breeding of Rhesus monkey. Journal of Animal Husbandry and Veterinary Science of Jiangxi 4: 16-17.

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