DISTRIBUTION STATUS OF COMMON LEOPARD (PANTHERA PARDUS) IN AND AROUND MACHIARA NATIONAL PARK, AZAD JAMMU AND KASHMIR

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Abstract

The present study was conducted to estimate the status of leopard (Panthera pardus) in and around the Machiara National Park (MNP) Azad Jammu and Kashmir between 2007 to July 2008, by counting the number of different pug marks on transects and sighting record information. Fifteen fixed transects were monitored on regular basis, people and livestock seen along the transects were also counted as an index of disturbance. Mean encounter rate for leopard scats, footprints, livestock and people were also calculated. Leopards' sightings were reported at 23 locations while cubs with mother were also sighted in the study area. About 30% sightings were recorded near water sources. Of the overall sightings, 35% morning, 15% day time, 29% evening time and 21% night time were recorded. Maximum sightings were recorded between 4765ft to 9634ft elevation in moist temperate zone with pinus wallichiana as a dominant species. Linear measurements of front and hind pugmarks and strides were classified which indicated that at least five to nine (05-09) individuals of leopard are present in the study area (13,532 ha). Mean encounter rate calculated for the leopard pugmarks was 1.928, for scat 2.022, for livestock 32.94, and for people 30.77. As a result of increasing biotic pressures, the leopard has become rare with growing threat of further degradation and fragmentation of its habitat. The information generated from the study will be helpful for the conservation and management of this critically endangered species.

Keywords: Common leopard; status; threats, Machiara National Park.

Introduction

Common Leopard (*Panthera pardus*) is the most widely distributed large cats worldwide, and is found throughout Africa and Asia [1]. The Leopard is quite adaptable with respect to habitat and food requirements, being found in intensively cultivated and inhabited areas as well as near urban development [2]. There is a wide variation in the ecology of the species across its range and in different ecosystems.

In Pakistan common leopards are found in the highlands of Baluchistan and Sindh, and mountain forests of Punjab, Khyber-Pakhtoonkhwa and Azad Jammu and Kashmir (AJ&K). It inhabits broken hilly or mountainous country throughout Waziristan, Baluchistan and Sindh Kohistan in association with *Acacia* scrub forest [3]. In the northern mountainous region, it is found in the Murree Hills, Swat, Kohistan, Dir, Chitral, Abbottabad, Kaghan Valley, Gilgit,

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Margalla Hills National Park and Neelum Valley in AJ&K. Increased human settlement as well as the possession of firearms has made the leopard extremely rare in Pakistan including in the remote mountain regions [3].

Their greater adaptability is due to their catholic diet which even includes arthropods, amphibians, rotting carcasses, their lesser dependence on free water (obtaining it from their prey), and their smaller size, which reduces the area needed to sustain a population compared to their larger cousins and makes it possible for them to live closer to human habitation [4]

Estimates of animal abundance are among the most important requirements of wildlife managers and researchers. Developing methods for collecting distributional data is essential for several purposes: knowledge on geographical distribution, habitat-relation models, effects of land-use changes, effects of human density and disturbance on distribution, relationship between species occurrence and landscape physiognomy and composition, viability models, population-monitoring programs, which ultimately determine the convenience of protecting a species [5].

Reliable estimation of population size is a key component in wildlife ecology, conservation and management [6]. This is also required to identify the priorities in allocation of limited resources, formulate conservation strategies, evaluate conservation programs and developpment approaches of effective management towards the species [2, 7].

To have effective conservation management use of indices, particularly those based on counts and measurements of presence signs (tracks and scats), have received much attention in recent years to describe the status and trends of wildlife populations [8]. This approach is promising and practical in studies of large predators, which are generally sparsely distributed, secretive, nocturnal and mostly solitary [9].

Studies showed that track measurements can be efficiently used to recognize individual felids as their shapes and sizes vary between ages and sexes across various taxa e.g., *Panthera tigris* [10, 11], *Panthera parduus* [9], *Panthera uncia* [12] and *Puma concolor* [13]. As track measurements depend on soil types, slopes and even involved personnel, this methodology needs strict standardization [13, 11]. Conducted study showed that leopard densities have been recorded previously in a number of sites such as Rhodes Matopos National Park, Zimbabwe (23.6 leopards/100km^2), South Africa (23.8 leopards/100km^2), India [14, 15].

In general, leopard home range size could be as small as 8.8km^2 in a prey rich habitat [16]. In district Rawalpindi Pakistan, the overall population estimates with in a 281km^2 habitat was 5.058±4.496, indicating that 1-9 leopards survive in its distribution range [17]. This study showed that population of common leopard is randomly distributed in the study area and having no preference for a particular habitat. At global and national levels, large carnivores are regarded as flagship species, and conservation efforts aim to maintain or reestablish viable populations [18].

Increased human settlement as well as the possession of firearms has made the leopard extremely rare in Pakistan including in the remote mountain regions [3]. The status assessment of mammals categorized the common leopard as a critically endangered species in Pakistan [19].

As the population status of leopard was unknown in MNP, the present study is the first of its kind to estimate the population of critically endangered leopard, and quantifies biotic pressures in terms human disturbance in MNP. Two different methodologies were used: (i) sighting record information; and (ii) pugmark survey.

Materials and Methods

The area of Machiara has high levels of biological diversity the division of the State of Jammu and Kashmir its forests were preserved as the hunting reserve for the Maharaja of

Kashmir. Machiara Wildlife Sanctuary was upgraded as National Park in 1996 covering an area of 13,532 ha, lies at 34º31' N latitude and 73º37'E longitude, between 2000m to 4733m elevation (Fig. 1). Originally it was planned to be a Trans-boundary National Park as a joint venture with Khyber Pakhtoon Khawa Government. Due to its position it is located within a Himalayan biodiversity hotspot and the western Himalayan Endemic Bird Area, and is an Important Bird Area itself [20]. From biological point of view, the area harbors a variety of eco-zones, including temperate Himalayan mixed-forest/alpine-scrub-rangeland ecosystem providing habitats to thousands of wild species. The park provides a good habitat to some threatened and globally significant wildlife species [21]. The carnivore species of the area include the leopard, snow leopard (*Uncia uncia*), leopard cat (*Prionailurus bengalensis*), Asiatic black bear (*Ursus thibetanus*), Asiatic jackal (*Canis aureus*), and Red fox (*Vulpes vulpes*). Around MNP, there are around 29,680 people living in 30 villages that comprise the three union councils of Bheri, Machiara and Serli Sacha. Due to the harsh environment, the households and villages are spread out to enable better access to resources of farmlands, pasture and forests in and around MNP.
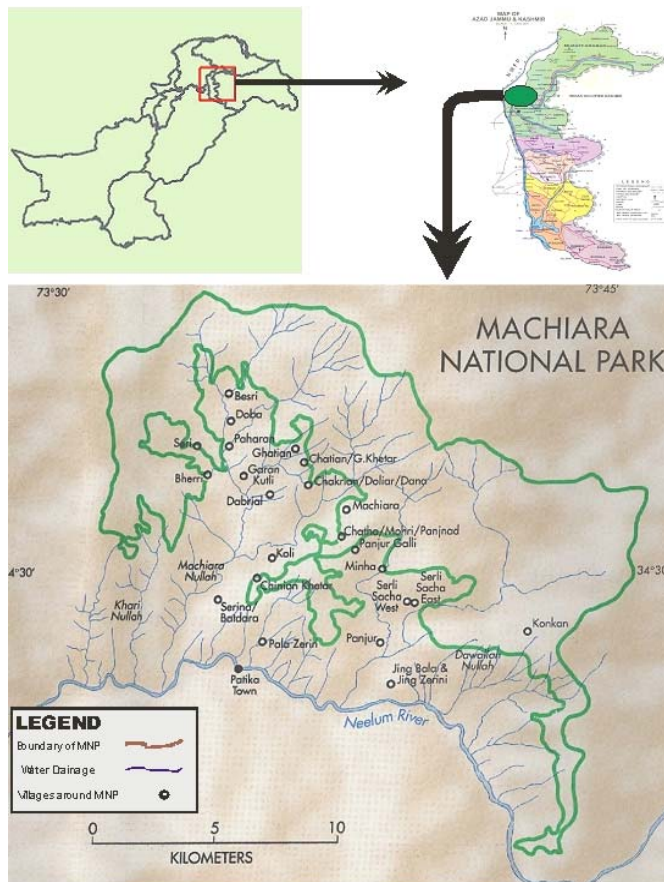

Fig. 1. Location map of study area (Machiara National Park)

Livestock (goat, sheep, cow, buffalo, horse and donkeys) constitute a major element of the local economy. Cows and buffaloes are kept as dairy animals, while goats and sheep are kept for their meat and wool and are the animals most commonly sold in the market. Due to the

lack of transportation services and infrastructure, horses, mules and donkeys are still used particularly in the remote villages [21].

The study was carried out in three selected study sites of the MNP including, Machiara, Bheri, and Sarli Sacha (Table 1). On the basis of previous sighting record information and conflict with local community we identify potential locations where common leopard resided. Based on this, we decided to focus our survey efforts in the three selected sites of study area.

Table 1. Study sites for the scats collection of Common leopard in MNP

Study sites	Sites names	GPS Location	Dominant vegetation of the sites
Site 1	Bheri	N 34º30.989 E 73º33.744	Barmi (*Taxus wallichiana*), Blue pine (*Pinus wallichiana*), Fir (*Abies pindrow*), Spruce (*Picea smithiana*), Reen (*Quercus incana*), Guchh (*Vibrium foetens*) and Kainthe (*Indigofera gerardiana*).
Site 2	Machiara	N 34º31.555 E 73º38.031	Barmi (*Taxus wallichiana*), Blue pine (*Pinus wallichiana*), Deodar (*Cedrus deodara*), Fir (*Abies pindrow*), Spruce (*Picea smithiana*), Reen (*Quercus incana*), Guchh (*Vibrium foetens*), Bankhor (*Asculus indica*) and Takana (*Acer caesium*).
Site 3	Sarli Sacha	N 34º30.036 E 73º38.474	Blue pine (*Pinus wallichiana*), Deodar (*Cedrus deodara*), Guchh (*Vibrium foetens*), Kainthe (*Indigofera gerardiana*) and Barth (*Prunus coruta*).

Questionnaire was developed and information collected on sighting record information, geographical location of the sighting and other evidences of the presence of leopard.

Complete counts of carnivore numbers are often impractical, expensive, and time-consuming. An alternative sampling measure was developed to estimate the abundance of tiger and leopard population based on pugmark census [10]. Main travel routes, roads, trails and locations known to be frequently used by leopard were preferred. After assessing the potential site Altogether, fifteen transects were drawn representing different habitats of the study area, where the indirect signs of the species were recorded. Signs such as scrapes, counting of the pugmarks and encounter rate of scats livestock and people of the area were recorded within four meters of both sides of transects. Transects were selected to be monitored on regular basis and walked early in the morning, before cattle effaced the signs, and in winter when the transect beds were wet when conditions were ideal for locating pugmarks. The data were expressed as encounter rate (number/km) in the analysis.

Paw Impression Pads (PIPs)

In the study area, all the leopard trails are passing through the forests or grassy areas, where it is impossible to get a suitable pugmark impression. To gain in-depth understanding with regards to the movement of the leopards at such places and to be able to record pugmark tracing or make a plaster cast, Paw Impression Pads (PIP's) with soft soil were developed. PIP's of 03m length and 01m wide were placed along the identified leopard trails with due regard to the overall topography of the study area.

Measurements of pugmarks

The length and breadth of the pugmarks were measured irrespective of the fact that whether they were either of fore or hind foot. The measurements and the continuity of the pugmark were used to distinguish different individuals on the same trails. For each encountered track, seven linear measurements were taken and following points were noted: A: track length. B: track width, C: pad width, D: pad length, E: diameter distance between top of second (left) toe and right pad curve, F: diameter distance between top of third toe and left pad curve, G: Stride size (in mm) [11].

Pugmarks Tracing

Pugmark tracing technique was used to get suitable pugmark impressions in order to get information about the leopard's movement. Tracing mirror and plaster casts were used as tool to get paw impressions. The glass plate supported by screw is placed over the pugmark. Tracing mirror was used for tracing the pugmark of the common leopard. It is a transparent glass plate of $20 \times 20 \times 20$. The thickness of glass plate is 3mm. After the search and examination of pugmark, the pugmarks with clear relief edges and sharp feature were selected for tracing. Partially superimposed or pugmarks with fuzzy boundaries were discarded. Another source of variability is the variation between individual tracer's ability to trace the features of the pugmark over the tracing sheet [7]. The tracing is transferred to tracing paper, by placing it over the tracing paper over the tracer, and redrawing the outlines of the pugmark on the tracing paper. Preservation of the pugmark is done by pouring plaster of Paris into the print and taking a cast. The kind and degree of human influence in the habitat was evaluated by evidence of disturbance such as human settlements, history utilization of forest products, human leopard conflict and overgrazing of livestock through information acquired by interviewing local inhabitants, hunters, government officials and biologists [7].

Results and Discussion

Preliminary information on the distribution of leopard was collected through informal interviews with National Park staff, villagers, and herders. Moreover, formal discussions were made with villagers regarding current distribution of leopard in and outside the park. Animal sightings were recorded and other signs (scats, scrapes, pugmarks and etc.) were also recorded to confirm the presence or absence of the leopard. Data was analyzed through combining the results of all interviews and questionnaires which was very critical to ensure the accuracy of the data.

Encounter rates of the footprints, scats, livestock and people.

After assessing the potential site we walked along the trails used by livestock, villagers which are mostly used by common leopard. We documented the livestock, people, scats and other signs as encounter rate. We verified the presence of leopard with clearly identifiable sign including pugmarks, scats, and scrapes when walking along the trails. We also documented body parts of livestock that were shown to us by local people and that could be related to time and place of collection, and considered them recent evidence of livestock killing.

Finally, we considered connections between leopard and people, including depredation of livestock, as evidence of leopard presence when we had reasonable assurance that leopard were indeed involved. Fifteen fixed monitoring tracks were surveyed to get the mean encounter rate for leopard scats, footprints, livestock and people seen in the area (Table 2). During the study period Mean encounter rate calculated for the leopard footprints was 1.928, for scat 2.022, for livestock 32.94, and for people 30.77. This information showed that the study area is highly disturbed because of the human activity (grazing, and fuel wood and fodder collection). As the local community depends upon the natural resources of study area like wood for house construction, fuel wood collection, livestock grazing and fodder collection. The encounter rate of people and grazing livestock were high as compare to the presence signs of the concerned specie. The main threats to this endangered species are due to human disturbance and habitat destruction in the form of forest cutting, livestock grazing and fodder collection due to which their natural habitat is shrinking day by day.

Table. 2. Details of permanent transect for regular Monitoring in Machiara National Park

Track code	Tracking area	Length (km)
UBL – 1	Behri, Chakerian, Deberyol, Danna, Thora top	7 km
UBL – 2	Behri, Galikhetar, Gatian, Thora, Sar, Loon,Kuthili, Khori, Jabra, Sell, Kuldabar.	20 km
UBL – 3	Galikhetar., Loon, Theelan, Musagali, Behsri, Doba.	12 km
UBL – 4	Behri, Dana, Behk, Khoon, Panna, Farm place.	5 km
UBL – 5	Behri, Nullakallus.	8 km
UML – 1	Machiara, Qabaya, Phaka, Kornakha, Chakrian, Kali, Dilmar, Khatar.	6 km
UML – 2	Machiara, Duliar, Danna, Kuthiali, Thora, Copra, Kalajabra.	8 km
UML – 3	Machiara, Mohrri, Chimnian, Uperjabra.	5 km
UML – 4	Machiara, Chatian, Khtahra, Husno, Trappa, Kalanvan, Ban, Khokar, Panjoor.	5 km
UML – 5	Machiara, Domail, Kathe, Baknari, Doggi, Low revri, Gumlan.	4 km
USL – 1	Sarli sacha, Magra, Kassi.	8 km
USL – 2	Sarlisacha, Chogalgali, Dapper, Tarkannagali.	5 km
USL – 3	Chugian, Pyazwala, Behla, Bari Behk, Nalla, Jingbala, Richbehla.	4 km
USL – 4	Sarisacha, Trappa, Buchian, Sukar Kassi, Ranga, Chitta Kashkar, Chiritora, Thora.	9 km
USL – 5	Hola, Panjoorgali, Thora, Konkan, Medan, Plani.	11 km

Population estimation

Population size (or abundance) and density, are parameters of critical importance to studies that aim to understand how animal species adapt to their environments as well as to studies that try to address conservation issues affecting these species. Large carnivores are generally considered to be among animals that are threatened most by human impacts. Population size and trend estimation is the first step in understanding the structure and dynamic of any natural population [22]. The collection of data was carried out periodically on the monthly basis using transects that covered the whole study area. We used track measurements to estimate the leopard population, data collection was conducted systematically and measurements were obtained from tracks on similar slope and substrate conditions to reduce the associated errors. We photographed and measured all pugmarks found while walking on trails. Leopard pugmarks were encountered in all the three study sites including Machiara, Behri and Sarli sacha. Understanding the variation in population density among different species within habitats and within species across habitat is of central importance in wildlife ecology and critical to conservation efforts of threatened and endangered species [23, 24].

A total of 47 pugmarks and strides of leopards were encountered in the field. However, only 09 tracks and strides were used for analysis because of pace pattern, unclear borders of the tracks or substrate and slope condition. Data collection was conducted systematically and measurements were obtained from pugmarks on similar slope and substrate conditions to reduce the associated errors. Although, it is not possible to produce an accurate population estimate of leopard we suggest that leopard density Machiara study site is unusually high due to rapid shrinking and fragmentation of the forested habitat from rest of the area. Pugmarks measurements work well on estimating sizes of small populations of felids, so we believe that our leopard census is accurate and reliable [9, 10]. Track length has manifested itself as much more reliable character in individual recognition of leopards [11, 12, 25] (table 3).

Felid tracks have an overall circular shape, with length and width about equal. A full-grown common leopard will have a track that measures 7.5 cm in width and 11cm in length, with the main pad at 4-7.5 cm [26]. We combined the data from right leg tracks with the data from left leg tracks because previous studies demonstrated little variability among most linear measurements from left and right tracks [12].

Table. 3. Pugmarks Details of the identified individual leopards

Track Code	Length (cm)	Width (cm)	Foot	Sex
SL1	8.1	7.0	FF	Female
	7.8	6.8	HF	
ML1	7.1	6.0	FF	Female
	7.2	6.4	HF	
ML2	8.3	8.4	FF	Male
	8.1	8.0	HF	
SL2	7.4	6.8	FF	Female
	7.1	6.6	HF	
SL3	8.3	7.8	FF	Female
	7.9	7.7	HF	
BL1	9.5	9.4	FF	Male
	9.4	9.4	HF	
ML3	8.6	7.9	FF	Female
	8.1	7.5	HF	
ML4	8.3	8.8	FF	Female
	7.5	7.9	HF	
BL2	8.1	8.0	FF	Male
	8.0	7.6	HF	
Total	06F + 03M = 09			

The individual leopards were distinguished from each other and their localities were monitored regularly throughout the study area. On the basis of information it could be argued that, the study area have a maximum number of 09 leopards in 13532ha were identified as individual leopards (Table 4) largely confined to the Machiara study site followed by Behri and sarli sacha sites of the study area. As a pioneering initiative, this study confirmed the healthy population of leopard and gives preliminary data on distribution status of leopard in MNP. The leopard being the predator has significant function in maintaining the shape of the ecosystem. Therefore, existence and healthy population size of the leopard could be used as sign of sustainable conservation and management of the species in the area.

Table. 4. Counts and encounter rates (no. /km) of leopard pug marks, livestock and people seen in and around Machiara National park May 2007 and July 2008

Track Code	Walked (Km)	Leopard Footprints (ER)	Scat (ER)	Livestock (ER)	People (ER)
Pugmark Survey in Union Council Sarli Sacha and surrounding areas					
USL-1	08km	01(0.125)	02(0.25)	20(2.5)	10(1.25)
USL-2	04km	01(0.25)	01(0.25)	14(3.5)	11 (2.75)
USL-3	09km	01(0.111)	02(0.222)	23(2.55)	21(2.33)
Pugmark Survey in Union Council Bheri and surrounding areas					
UBL-1	7km	01 (0.142)	00(00)	06(0.85)	09(1.28)
UBL-2	20km	01(0.05)	02(0.1)	65(3.25)	88(4.4)
UBL-3	05km	01(0.2)	00(00)	21(4.2)	09(1.8)
UBL-4	08km	01(0.125)	03(0.37)	06(0.75)	11(1.38)
Pugmark Survey in Union Council Machiara and surrounding areas					
UML-1	09km	02(0.222)	02(0.222)	10(1.11)	08(0.89)
UML-2	08km	01(0.125)	02(0.25)	15(1.87)	22(2.75)
UML-3	05km	00(00)	01(0.2)	11(2.2)	07(1.4)
UML-4	04km	01(0.25)	01(0.25)	09(2.25)	09(2.25)
		1.60	2.11	25.03	22.48

Thick and protected sites of the national park provide potential habitat for the species. As the surrounding area of the MNP is highly disturbed by local communities and leopards moved to protected sites of study area. Leopard requires large territories and is sensitive to

human induced disturbance, habit loss or fragmentation and a reduced prey-base. In Pakistan, leopard is a nationally protected species but has been heavily persecuted because of conflicts with rural communities and poached for its fur; it has consequently declined or disappeared over vast areas of its former range [27, 17]. Measuring densities of leopard under ecologically different conditions would thus help assess the factors that determine hyena distribution and abundance as well as their ability to survive in human dominated landscapes under severe anthropogenic pressures.

Sighting Record Information Collection

We obtained preliminary information about leopard occurrence from indigenous and knowledgeable people that live close to the forest. Sightings of leopards have frequently been reported by local communities in the study area. During the study period leopards have been sighted by local community at 23 places. The geographical coordinates of all the sighting places were recorded and plotted on the GIS for the year 2007 and 2008 (Fig. 2). In the year 2007, leopards have been sighted at 13 places, in the year 2008 in 10 places (up to August).The number of leopard sighting was higher in the (Y2007) months of May (23%), June (15%), July (15%) and December (15%) as compared to the rest of the year. The number of leopard sighting was higher in the (Y2008) months of May (20%), June (30%), and January (20%) as compared to the rest of the year (Fig. 3). The number of sightings inside the villages was higher than the sighting inside the forests area. About 35% sightings happened near the water sources (Fig. 4). Number of the sighting at different time is different. In the summer season day time and night time sighting of leopard was high while the morning and evening time sighting was high in the winter. About 30% sightings happened near the water sources. Out of total sightings, 35 % recorded in morning, 15% at the day time 29% in the evening time and 21% in the night time (Fig 5).
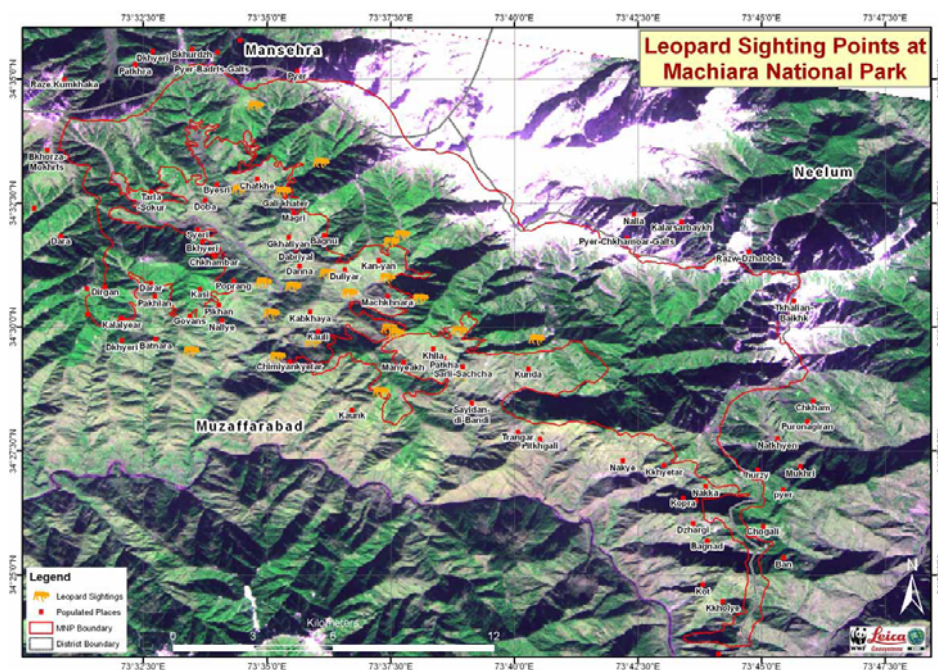

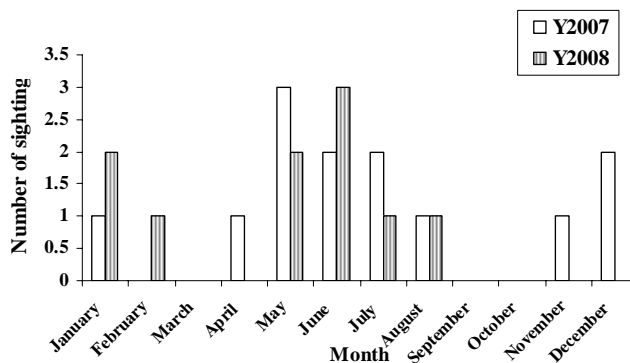**Fig. 2.** Sighting of common leopard in the area

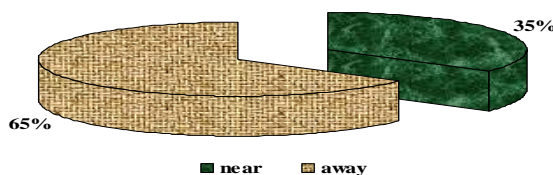**Fig 3.** Sighting of Common Leopard during different months of 2007-2008 in the study area.

Fig 4. Sighting of Common Leopard near water sources during 2007-2008 in study area.

The people that lived near to the potential habitat of leopard at Kornakkah and Nallah Kalus locality mostly saw the leopard with two cubs in the evening and the morning time. In the year 2007, cubs sighted with mother at Kornakkah Nallah Kalus and Buchian cheeritora and during 2008 cubs sighted with mother at three different places (Kornakkah, Nallah Kalus, and Danna Bheri. The sighting results of the year 2007 up to August, 2008 with respect to time are provided. Leopard sighting in the villages particularly at morning and evening time has increased manifold currently than in the past.
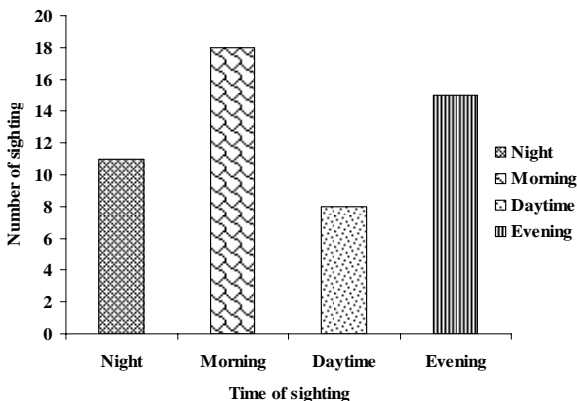

Fig. 5. Time of the sighting of the Common Leopard during 2007-2008 in Study area

This could be attributed to two reasons that its prey species population in its core habitat has decreased considerably that compelled leopards to come down to villages in search of food. The other factor is increasing human population, results in higher level of disturbance in the

leopard habitat. The leopard habitat is being used constantly and consistently by the local for their fuel wood and fodder requirements. It is clearly evident from the sighting record that, leopards population in and around the park peripheries is randomly distributed. In the summer, people move to the forest and pasture and when they were grazing their livestock and search the forests for the fuel wood and fodder collection accidentally the sighting of the leopard happened. Some people go long distance daily and return at night time and when they move back to the home mostly encounter with the leopard sighting. While in winter when people moved back from the forest and pasture to the village, in search of the food the leopard have been sighted mostly in the evening and the morning time near the villages.

Local Community Attitudes, Towards the Common Leopard Conservation

Successful carnivore conservation depends on indigenous people attitudes and tolerance for livestock losses. We examined of local community towards the conservation of leopard. Our results showed that about 92% have negative attitude towards the conservation of leopard because of predation of livestock, while 8 % locals have positive views by knowing the role of top predator in our ecosystem. As the main source of income of local community is the livestock rearing and depend upon the natural resources of park. Habitat degradation and depleted wild prey base may cause the species to shift their diet on the available domestic livestock available in and around the area which result in human leopard conflict.

Threats

Long term survival of leopard population in this area is threatened due to the presence of various disturbances in the habitat. The main threats to the existing population of approximately 09 leopards in MNP are habitat degradation, prey depletion and human leopard conflict. Habitat degradation includes disturbance in the form of forest cutting, livestock grazing and fodder collection due to which their natural habitat is shrinking day by day. Growing livestock population can create forage competition with wild ungulates, resulting in overgrazing and decline or local extinction of wild prey of leopard. As result of livestock depredation killing of leopard were also reported from the study area. All these factors contribute to declining the population of this critically endangered species and if situation remains constant it is rapidly moving towards the extinction if future.

Conclusions and Recommendations

According to our study on the common leopard (*Panthera pardus*) in and around Machiara National Park, Azad Jammu and Kashmir, we can state the following:

- As a result of low density of wild prey rate of the livestock depredation is increasing which causes killing of leopard. Therefore natural prey species should be conserved preventing their poaching, habitat loss and human disturbance at least in core area.
- Overgrazing result in competition with wild ungulate that serves as the natural prey of leopard. The removal of livestock from leopard habitat also increases the amount of good grazing available for wild prey specie. There should be rotational grazing in the area. Poor herding practices, unsecured corrals inside homes are among the major contributing factors for the livestock losses.
- Understanding the patterns connected with livestock predation can be used to alleviate its effects and promote more stable coexistence of leopard and humans.
- Educate village level communities about function of the predator in maintaining the natural ecosystem; local people will be more supportive in case of leopard situation in the areas.
- Research and monitoring related to leopard issues must continue for better understanding of the conflict and its resolution to an acceptable limit.

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