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Seasonal Diet Composition of Leopard (*Panthera pardus*) in Machiara National Park, Azad Jammu and Kashmir, Pakistan

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Abstract.- Machiara National Park, Pakistan, is famous for its faunal diversity especially the leopards. These leopards feed on a variety of wild and livestock animals, however the data regarding their diet composition is scanty. The present study was, therefore, designed to find out the seasonal variation in the diet composition of leopards (*Panthera pardus*) at Machiara National Park, Azad Jammu and Kashmir. Scat samples were collected during summer and winter seasons and hair mounting technique was used to identify different species consumed by *P. pardus*. Grey goral (18.08%) was amongst the most preferred dietary species consumed by *P. pardus* during winter season, while Indian pika (13.45%) was most frequently used as diet during summer season. Other species include musk deer, cape hare, monkeys, Royle's mountain vole, Kashmir marmot, stoat, musk rat, house mouse, flying squirrel, Himalayan palm civet, house rat, sheep, goat, cow, horse, red fox, birds and some unknown species. Furthermore, habitat analysis, predator-prey relationship and human-carnivore conflicts were also assessed.

Keywords: Carnivore, hair mounting, predator, prey, scat, *Panthera pardus*.

INTRODUCTION

The populations of large carnivores are declining and the situation is creating an imbalance between the carnivores and their prey populations (Estes *et al*., 2011; Dickman *et al*., 2011). Major threat to the survival of these carnivores is the human-wildlife conflict therefore the populations living in close proximity of human habitations are on the verge of extinction (Carter *et al*., 2012).

The leopard has wide distribution among big cats due to its feeding habit, highly adaptable hunting and hermit like nature. It has been declared as near threatened species by the International Union for the Conservation of Nature (IUCN) (Henschel *et al*., 2008). Degradation of natural habitat, deforestation, conflict with humans and poaching are the major factors responsible for the decline of leopard populations (Henschel *et al*., 2008; Aryal and Kreighenhofern, 2009). In Pakistan, a variety of big cats including leopard (*Panthera pardus*) have been conserved by establishing wildlife parks (Roberts, 1997). Leopard is a very successful predator because of a number of reasons *i.e.*, its larger size and adaptability to diverse habitats (Ramesh *et al*., 2009). Leopards usually adapt habitats impenetrable for humans by altering their dietary habits (Goyal *et al*., 2000). They are highly opportunistic and can kill livestock in addition to wild prey (Michalski *et al*., 2006). However leopards prefer, prey species weighing between 10 to 40 kg (Hayward *et al*., 2006) and their behavior varies according to the type of habitat (Daniel, 1996).

Predator/prey relationships are the key indicator of the structure and functioning of any ecosystem (Duffy *et al*., 2007) and the dietary analyses of predators are helpful to find out the key environmental resources required to conserve any species (Cristo bal-Azkarate and Arroyo-Rodrı´guez, 2007). Leopard is an opportunistic carnivore with a wide geographical distribution and utilizes food according to local availability (Ott *et al*., 2007). Further studies are necessary for successful conservation of the leopard regarding competition with sympatric carnivores, status of major prey populations and methods to decrease human–leopard conflicts (Taghdisi *et al*., 2013).

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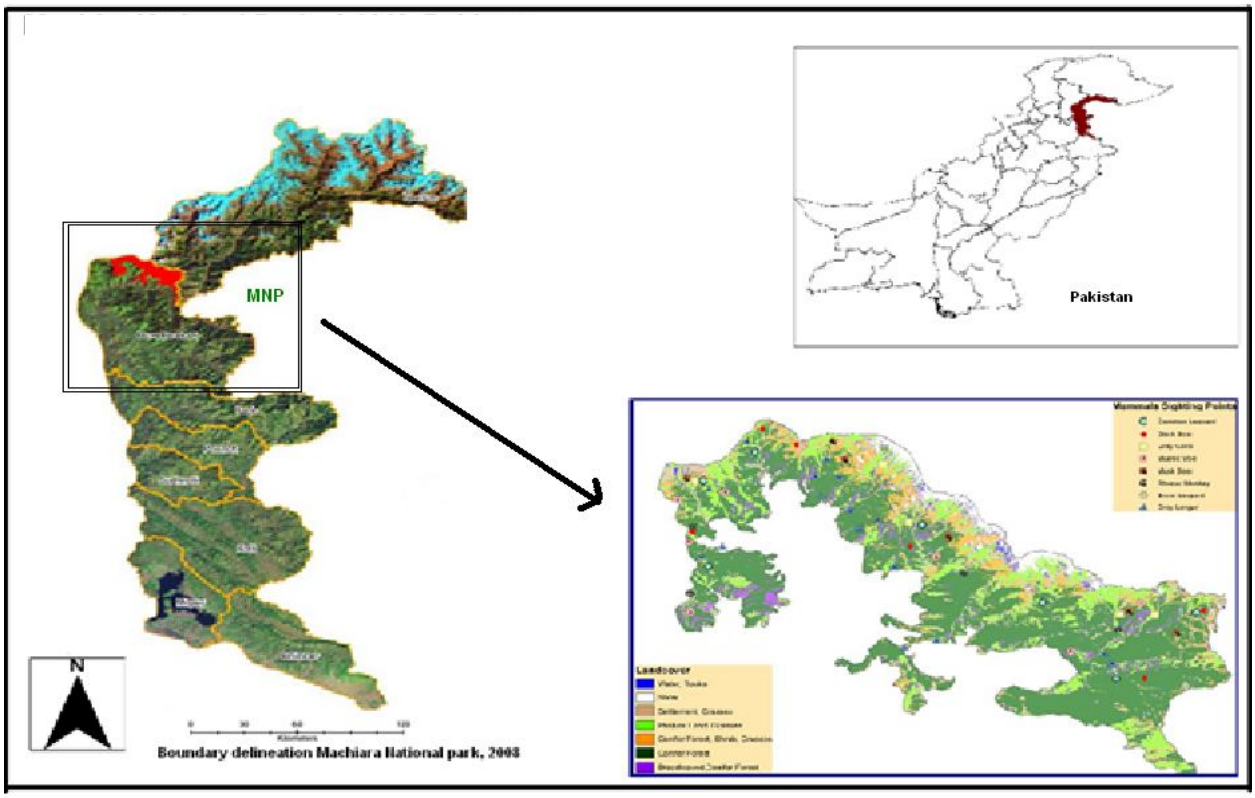

Fig. 1. Boundary delineation of Machiara National Park. GIS Laboratory, WWF, Pakistan.

Although, reasonable populations of leopards (*P. pardus*) inhabit Machiara National Park but the data regarding its feeding habits and diet composition is scanty. The present study was therefore designed to investigate the seasonal diet composition of leopard during different seasons.

MATERIALS AND METHODS

Study area

Machiara National Park (MNP) was declared as a game reserve in 1982 under the Azad Jammu and Kashmir (AJK) Wildlife Act, 1975 and given the status of National Park in 1996. MNP covers an area of 13,532 ha and lies at 34°- 31° N latitude and 73°-37° E longitude (Fig. 1). It is situated in the Himalayan Highlands of AJ&K, on the right bank of the Neelum river and lies 35 km away from Muzaffarabad and 165 km from Islamabad. MNP is bounded by Kaghan Valley, Khyber Pakhtunkhwa from its western side whereas, 30 main Villages are present on its the southern periphery (Dar *et al*., 2009; Minhas *et al*., 2012). MNP consists of three union councils named Bharie, Machiara and Sarlisacha. The parks contain evergreen broad-leaved and deciduous broad-leaved forest type plantations. The Wildlife and Fisheries Departments manage their field staff and keep census data on the basis of union councils (Dar *et al*., 2009). A total of 42 mammal species has been reported from MNP, of which 19 species are small mammals, 6 are carnivores, 9 are rodents, 2 are lagomorphs and one species from insectivorea and chiroptera each (Baig, 2004; Awan *et al*., 2004). Moreover, more than 100 species of birds, (Hassan, 2004)**,** 25 species of reptiles and 7 amphibian species have been reported from MNP (Baig, 2004). High species richness at MNP is attributed to different habitat types and variations in extreme altitudes and the slopes of the mountains (Awan *et al*., 2004)**.**

The climatic conditions vary throughout the year in the study area. MNP has a cold winter and heavy snowfall in the moist temperate regions. High

altitude peaks remain covered with snow until June or even later, followed by lush green vegetation. The annual rainfall is 1526.7 mm. The rainiest month is July (327.6 mm rain), while the least rainy month is November (35.4 mm mean rainfall), (Pakistan Meteorological Department, 1990).

Leopard scat survey

Surveys were conducted to collect sign (scats, scraping, pugmarks, and scent spray) of leopard for a period of one year. The signs of leopard were identified on the basis of size, shape, color and other physical features (Fig. 2). The study area was divided into three blocks, Seri Sacha, Machiara and Bheri union councils, of which 64 existing human and livestock trails each 1.5 km in length were surveyed to collect leopard scat and were identified by using field study guides (Stuart and Stuart, 2007). The study area was surveyed on fortnightly basis for the collection of leopard scats in summer and winter season. Collected leopard scats were preserved in polythene bags and labeled having information about date of collection, site and health condition.

Fig. 2. Scat of leopard identified from the study area.

Scat analysis and leopard diet identification

Scat analysis using hair-mounting technique is commonly used to determine diet in a wide variety of carnivore species (Chattha *et al*., 2011). The collected scat samples were sun dried in the open air, washed with tap water in a fine cotton cloth. Each sample was further cleaned with 3cc carbon tetrachloride and dried between absorbant papers for detailed examination. Hairs, bones, needles and stones were separated. All the components were weighed to observe the percentage of each ingredient. For further slides, hairs were randomly selected from each of the scat for examination of cuticle scales pattern. Prey species were identified mainly from the macroscopic and microscopic structure of hairs. Hair of preys was used for species identification by magnifying cuticular scale patterns of hairs and medullary structure under photomicroscope (magnification 100X to 400X) and further compared with reference books (Mukherjee *et al*., 1994; Chattha *et al*., 2011).These evidences were further substantiated from the remains of bones, claws, hooves, feathers and other undigested remains found in the scats.

Mounting of hair slides

Long hairs were divided into two or more pieces before they were placed on the glass slide. Different types of hair were mounted using DPX (distrene plasticizer xylene) as a mounting medium under a compound. At least ten hairs selected from each scat sample were matched and crossed checked for detection of multiple prey items. The morphological characteristics of the cuticle, the medulla and the distribution of pigment in the cortex were assessed to identify prey species by using whole mount method (Robertson, 1999). Furthermore, to check the scale pattern more clearly, particularly in the identification of some animals, the scale replicates method was used. A scale cast was made using nail polish to obtain the impression of the scales. The scale pattern was observed under a microscope. All the slides were observed under digital camera microscope and the shot photos were compared with the reference slides Figure 3 (Mukherjee *et al*., 1994).

RESULTS AND DISCUSSION

During present survey, local people in the MNP, AJ&K were interviewed to know the locality of leopard and its attack on livestock animals. The study was divided into three blocks and pugmarks and scratches of the leopard in the human trafficking roads and highly colonized areas were searched. The prime objective of the present study was collection of scat samples of *P. pardus* and identification of

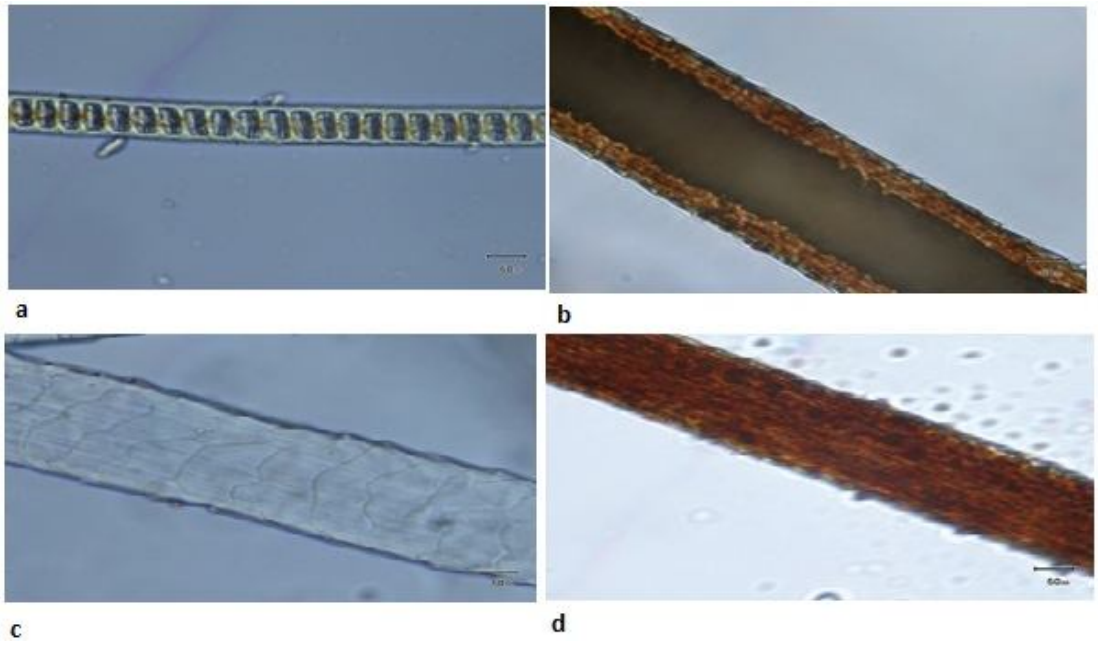

Fig. 3. Microscopic structure of hairs of Indian pika (a), muskdeer (b), local sheep (c) and goat (d).

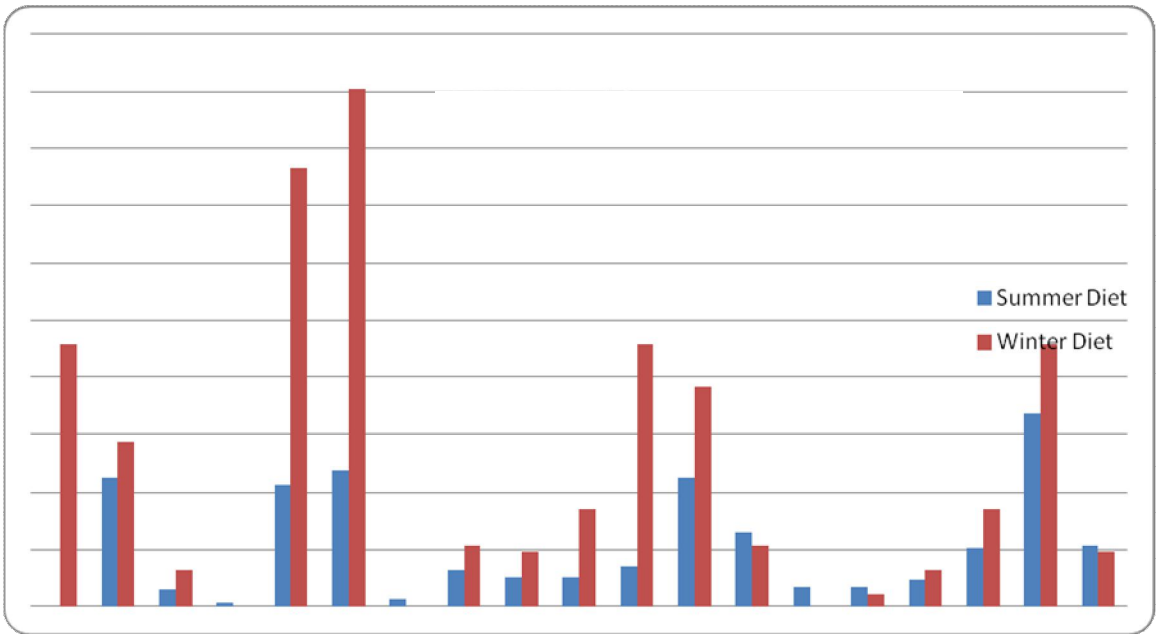

Fig. 4. Seasonal diet analysis of leopard in MNP, Pakistan.

various prey species consumed as food source. Because, the scat analysis is a well-accepted technique to study carnivore diet ecology (Bianchi *et al*., 2011) although, the sampling of leopard's scat is very difficult (Hayward *et al*., 2006).

A total of 105 scat samples, 58 during summer and 47 during winter season were collected from MNP, AJ&K during present study and a total of 20 prey species were identified during both winter and summer seasons (Fig. 4). A variety of

animal species were consumed by the leopards during both the seasons. Among the wild animals, Indian pika (13.45%) was the most preferred dietary species during summer, whereas grey goral was amongst the most preferred (18.08%) dietary species during winter season. The present study revealed that although domestic livestock are consumed by the leopards but wild ungulates were the major food items. Our findings are in line with Ott *et al*. (2007), Norton *et al*. (1986) and Ogara *et al*. (2010) who reported high wild ungulate predation compared to domestic livestock by leopard. Taghdisi *et al*. (2013) also reported that wild ungulates including wild sheep, wild goat and wild pig are amongst the most preferable food items of leopards accounting 85.98% of their consumed biomass compared to 3.26% biomass consumed for livestock. Himalayan palm civet (0.52%) and house rat (0.43%) were the least consumed prey species during summer and winter seasons, respectively. Furthermore horse, house mouse and Himalayan palm civet were consumed as diet during summer season only. Three species of domestic animals i.e. goat, cow and horse were identified from the scat samples of *P. pardus*, of which goat was the most preferred dietary species during both the summer (12.07%) and winter (9.15%) seasons (Table I).

During present study, it was observed that overall, wild ungulates (33.4%) and meso-mammals (26.4%) were most frequently consumed food items in winter season, whereas livestock animals (22.59%) and small mammals (22.24%) were most frequently consumed during summer season. It was noted that the small mammals make a significant part of leopards' diet during both summer (22.24%) and winter (14.26%) seasons. Small mammals constitute significant part of leopard diet (Zhirjakov, 1990; Aryal and Kreighenhofern, 2009) and are of more importance when the major and favorite food items are not readily available.

Remnants of a few birds and rodents (house mouse) were also identified from the scat samples of leopard during present analysis, indicating the diversity of prey species. Birds were amongst the least consumed prey species during summer (4.31%) as well as winter (1.92%) seasons. The same observations were documented by Hayward *et al*. (2006).

Table I.- Occurrence of prey species based on hair in leopard scat summer (n=58) and winter (n=47).

Common name	Summer No. of occurrence % prey contribution	Winter No. of occurrence % prey contribution
Musk deer	49 (8.45)	72 (15.32)
Cape hare	16 (2.76)	43 (9.15)
Monkeys	30 (5.17)	21 (2.13)
Indian pika	78 (13.45)	43 (9.15)
Royle's mountain vole	24 (4.14)	16 (3.41)
Grey goral	55 (9.48)	85 (18.08)
Kashmir marmot	43 (8.96)	36 (7.66)
Stoat or ermine	12 (2.06)	9 (1.92)
Musk rat	11 (1.89)	6 (1.27)
House mouse	8 (1.38)	-
Flying squirrel	12 (2.07)	16 (3.41)
Himalayan palm civet	3 (0.52)	-
House rat	8 (1.38)	2 (0.43)
Red fox	15 (2.58)	10 (2.13)
Birds	25 (4.31)	9 (1.92)
Sheep	52 (8.97)	27 (5.74)
Goat	70 (12.07)	43 (9.15)
Cow	7 (1.21)	6 (1.27)
Horse	2 (0.34)	-
Unknown	60 (7.24)	26 (5.54)

Chi square analysis revealed significant differences ($p<0.05$) for consumption of livestock animals, meso-mammals and small mammals as diet of *P. pardus* during both the summer and winter seasons (Table II). Very little is known about alternate availability of leopard prey however, alternate prey availability has major role in the life of the leopard when the major food items are not accessible (Shaw, 1997). During present study smaller and meso-mammals *viz.* Indian pika and cape hare were used as alternate food sources during summer and winter seasons.

CONCLUSIONS

It can be concluded from the present study that leopards in MNP feed on a variety of animal species with significant dietary variations during summer and winter seasons. Furthermore, the leopard prefers wild animals as dietary source than domestic livestock. This study provides baseline data on the dietary composition of leopards at MNP

Table II.- Statistical analysis of seasonal variation in diet of leopard.

Group	Summer diet %	Winter diet %	x^2	DF	P-value
Livestock	22.59	16.16	13.11	3	0.004
Wild ungulates	17.93	33.4	0.059	1	0.808
Meso-mammals	24.12	26.4	14.87	5	0.011
Small mammals	22.24	14.26	23.94	4	0.000
Birds	4.31	1.92	-	-	-

during different seasons which is helpful in reducing human-wildlife conflict; however, further studies are needed on dietary aspects for proper management and conservation of leopards.

REFERENCES

ARYAL, A. AND KREIGENHOFER, B., 2009. Summer diet composition of common leopard *Panthera pardus* (Carnivora: Felidae) in Nepal. *J. Threat. Taxa*, **1**:562-566.

AWAN, M.S., MINHAZAND, R.A. AND AHMED, K.B., 2004. Distribution, food and habitat preferences of small mammals in Machiara National Park, district Muzaffarabad, Azad Kashmir, Pakistan. *Punjab Univ. J. Zool.*, **19**: 17-31.

BAIG, K.J., 2004. *Compilation of baseline data for zoological and wildlife studies in Machiara National Park*, AJ&K. PAMP.

BIANCHI, R.D.C., ROSA, A.F., GATTI, A. AND MENDES, S.L., 2011. Diet of margay, Leoparduswiedii, and jaguarundi, Pumayagouaroundi (Carnivora: Felidae) in Atlantic rainforest, Brazil. *Zoologica*, **28**: 127–132.

CARTER, N.H., SHRESTHA, B.K., KARKI, J.B., PRADHAN, N.M.B. AND LIU, J., 2012. *Coexistence between wildlife and humans at fine spatial scales.* www.pnas.org/cgi/doi/10.1073/pnas.1210490109

CHATTHA, S.A., ANJUM, K.M., ALTAF, M. AND YOUSAF, M.Z., 2011. Hair mounting technique: helpful in conservation of carnivores. *FUUAST J. Biol*., **1**: 53-59.

CRISTO BAL-AZKARATE, J. AND ARROYO-RODRI´GUEZ, V., 2007. Diet and activity patterns of howler monkeys (*Alouattapalliata*) in Los Tuxtlas, Mexico: effects of habitat fragmentation and implications for conservation. *Am. J. Primat*., **69**: 1-17.

DANIEL, J.C., 1996. *The leopard in India - A natural history*. Natraj Publishers, Dehradun.

DAR, N.I., MINHAS, A.R.A., ZAMAN, Q. AND LINKIE, M., 2009. Predicting the patterns, perceptions and causes of human-carnivore conflict in and around Machiara National Park, Pakistan. *Biol. Conserv.*, **142**: 2076-2082.

DICKMAN, A.J., MACDONALD, E.A. AND MACDONALD, D.W., 2011. A review of financial instruments to pay for predator conservation and encourage human-carnivore coexistence. *Proc. natl. Acad. Sci. USA*, **108**: 13937-13944.

DUFFY, J.E., CARINALE, B.J., FRANCE, K.E., MCINTYRE, P.B., THEBAULT, E. AND LOREAU, M., 2007. The functional role of biodiversity in ecosystems: incorporating trophic complexity. *Ecol. Lett*., **10**: 522-538.

ESTES, J.A., TERBORGH, J., BRASHARES, J.S., POWER, M.E., BERGER, J., BOND, W.J., CARPENTER, S.R., ESSINGTON, T.E., HOLT, R.D. AND JACKSON, J.B.C., 2011. Trophic downgrading of planet earth. *Science*, **333**: 301-306.

GOYAL, S.P., CHAUHAN, D.S., AGRAWAL, M.K. AND THAPA, R., 2000. *A study on distribution, relative abundance and food habits of leopards (*Panther pardus*) in garhwal Himalayas.* Technical report (December 1999 - July 2000)

HASSAN, S.A., 2004. *Compilation of baseline data for ornithological studies in Machiara National Park*, AJ&K. PAMP.

HAYWARD, M.W., HENSCHEL, P., BRIEN, J.O., HOFMEYR, M., BALME, G. AND KERLEY, G.H.I., 2006. Prey preferences of leopard (*Panthera pardus*). *J. Zool.*, **270**: 298–313.

HENSCHEL, P., HUNTER, L., BREITENMOSER, U., PURSHASE, N., PACKER, C., KHOROZYAN, I., BAUER, H., MARKER, L., SOGBOHOSSOU, E. AND BREITENMOSER-WURSTEN, C., 2008. *Panthera pardus.* In: IUCN 2009. 2009 *IUCN red list of threatened species.www.iucnredlist.org.*

MICHALSKI, F., BOULHOSA, R.L.P., FARIA, A. AND PERES, C.A., 2006. Human-wildlife conflicts in a fragmented Amazonian forest landscape of large felid depredation on livestock. *Anim.Conserv.*, **9**: 179-188.

MINHAS, R.A., AHMED, K.B, AWAN, M.S, ZAMAN, Q, DAR, N.I. AND ALI, H., 2012. Distribution patterns and population status of the Himalayan grey ;angur (*Semnopithecus ajax*) in Machiara National Park, Azad Jammu and Kashmir, Pakistan. *Pakistan J. Zool.*, **44**: 869-877.

MUKHERJEE, S., GOYAL, S.P. AND CHELLAM, R., 1994. Standardization of scat analysis techniques for leopard

(*Panthera pardus*) in Gir National Park, Western India. *Mammalia*, **58**: 139-143.

NORTON, P.M., LAWSON, A.B., HENLEY, S.R. AND AVAERY, G., 1986. Prey of leopards in four mountainous areas of the south Western Cape Province. *S. Afr. J. Wildl. Res*., **16**: 47–52.

OGARA, W.O., GITAHI, N.J., ANDANJE, S.A., OGUGE, N., NDUATI, D.W. AND MAINGA, A.O., 2010. Determination of carnivores prey base by scat analysis in Samburu community group ranches in Kenya. *Afr. J. environ. Sci. Technol*., **4**: 540-546.

OTT, T., KERLEY, G.I.H. AND BOSHOFF, A.F., 2007. Preliminary observations on the diet of leopards (*Panthera pardus*) from a conservation area and adjacent rangelands in the Baviaanskloof region, South Africa. *Afr. Zool.,* **42**: 31-37.

PAKISTAN METEOROLOGICAL DEPARTMENT, 1990. *Temperature and rainfall records in Muzaffarabad from 1961–1990.* Islamabad, Pakistan.

RAMESH, T., SNEHALATHA, V., SANKAR, K. AND QURESHI, Q., 2009. Food habits and prey selection of tiger and leopard in Mudumalai Tiger Reserve, Tamil Nadu, India. *J. Sci. Trans. Environ. Technol.,* **2**: 170-181.

ROBERTS, T.J., 1997. *The mammals of Pakistan.* Oxford University Press, New York.

ROBERTSON, J., 1999. Forensic and microscopic examination of human hair. In: *Forensic examination of hair*. Taylor and Francis, London, pp. 79-154.

SHAW, H.G., 1997. Impact of mountain lion on mule deer and cattle in Northwestern Arizona, In:. *Proceeding of the 1975 predator symposium* (eds. R.L. Philips and C. Jonkel), University of Montana. Missoula, pp. 17-32.

STUART, C. AND STUART, T., 2007. *Field guide to the larger mammals of Africa.* Revised Edition. Struik Nature, Random House Struik, SA.

TAGHDISI, M., MOHAMMADI, A., NOURANI, E., SHOKRI, S., REZAEI, A. AND KABOLI, M., 2013. Diet and habitat use of the endangered Persian leopard (*Panthera pardus saxicolor*) in northeastern Iran. *Turk. J. Zool*., **7**: 554-561.

ZHIRJAKOV, V.A., 1990. On the ecology of the snow leopards in the Zailisky-Alatau (Northern Tien Shah). *Int. Red Book Snow Leop.*, **6**:25-30.

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