ZOO-Journal **6**: 1-8, 2021 **Research Article** ***ISSN: 2631-2204***

DIET OF SNOW LEOPARD *PANTHERA UNCIA* IN KANCHANJUNGA CONSERVATION AREA

Hari Prasad Sharma[1,2*], Niraj Khadka[1], Maheshor Niraula[3]

[1]Central Department of Zoology, Institute of Science and Technology, Tribhuvan University, Kathmandu, Nepal

[2]Nepal Zoological Society, Kathmandu, Nepal

[3]Kanchanjunga Conservation Area Office, Taplejung, Nepal

*Correspondence: hpsharma@cdztu.edu.np

ABSTRACT

The population of Snow Leopard is declining due to anthropogenic activities and prey scarcity. Snow Leopard's preferred prey species are Tibetan Argali, Blue Sheep, Himalayan Tahr, Himalayan Marmot, Royle's Pika, rodents, and livestock such as Yak, Horse, Lulu Cow, Goat and Sheep. Due to livestock depredation by Snow Leopards and other carnivores, local people have a negative attitude towards carnivores' conservation leading to retaliatory killing. This study identified whether Snow Leopards prey on wildlife or livestock based on micro-histological study of Snow Leopard's scats. Micro-histological analysis of 39 scat samples of Snow Leopard confirmed that Blue Sheep is the major prey species in Kanchanjunga Conservation Area (KCA). The scat analysis also showed that Snow Leopards prey on livestock mainly to Chauri in KCA, however the number and incidences were few. The herders also confirmed the occasional hunting of their livestock depredation by Snow Leopard in KCA. People have positive attitudes towards Snow Leopard conservation because they are less suffering from Snow Leopard in KCA. If wild prey species are abundant in the wild, livestock depredation might be low.

Key words: Snow Leopard, diet, Kanchanjunga, Conservation.

INTRODUCTION

Many wildlife species are declining (Ceballos et al., 2015; WWF, 2020), mainly the top predators which are severely affected by anthropogenic activities in an ecosystem dynamic. However, many species are with little information on the occurrence (Katuwal et al., 2018) and their role in an ecosystem dynamic. Knowledge on species occurrence provides information about their distribution, diet, habitat and ecology, and spatial threats (Nowell and Jackson, 1996), which can support the development of a species- or site specific conservation actions plan (MoFSC, 2017). Globally, more than 41,000 species are threatened with extinction, and are with no more detain information for developing conservation action plan (IUCN, 2020). Among these, the Snow Leopard (*Panthera uncia)* is one of the least known mammals whose population has been declining since the nineteenth century (McCarthy et al., 2017). Snow Leopards are habitat specialists at distinct territories and can live in the areas where ungulate prey is abundant and moderate human-caused mortality (McCarthy et al., 2017). These are one of the major drivers for creating human-wildlife conflict in the rural areas due to their nature of livestock hunting (Hussain, 2003). The pattern

of preying livestock and wild animals by Snow Leopards are documented in some regions (Oli et al, 1993), however little information is available about their habitat range.

The Snow Leopards are listed as Vulnerable on the IUCN Red List of Threatened Species and is included in CITES Appendix I and Schedule I of Nepal's Wildlife Protection Act of 1973 (Jnawali et al., 2011; McCarthy et al., 2017). The species is distributed in Afghanistan, Bhutan, China, India, Kazakhstan, Kyrgyzstan, Mongolia, Nepal, Pakistan, Russian Federation, Tajikistan and Uzbekistan from 500 m to 5,800 m of elevation (McCarthy et al., 2017). The Snow Leopard's suitable habitat in the current world is estimated at approximately 2.8 million km^2 (McCarthy et al., 2017). In Nepal, the species is distributed in both protected areas at high altitude, and outside protected area such as Dolpa, Humla, Mugu, Manang, Mustang and Myagdi in cold, arid and semi-arid shrubland, alpine and subalpine areas, grasslands and open forests characterized by cliffs and ridges from 3,000 m to 5,500 m of elevation (Jnawali et al., 2011; Aryal et al., 2016). Nepal has approximately 12815 km^2 of potential landmass suitable to Snow Leopard (Aryal et al., 2018).

The global current population of mature Snow Leopard is around 2,710 to 3,386 individuals in the wild (McCarthy et al., 2017), and in Nepal population is around 300 to 500 individuals (Jnawali et al., 2011; DNPWC, 2017). However, the population of the species is declining mainly due to anthropogenic activities (McCarthy et al., 2017). Retaliatory killing, poaching for wildlife trade, habitat degradation and prey depletion are major drivers for Snow Leopard's population decline (Ripple et al., 2014). A recent study of Lyngdoh et al. (2014) on the prey preferences of Snow Leopards indicated a relatively narrow dietary niche breadth despite marked diet differences among regions with other carnivores. The main prey species of Snow Leopards are Blue Sheep (*Pseudois nayaur*), Tibetan Argali (*Ovis ammon*) and Himalayan Tahr (*Hemitragus jemlahicus*) and sometimes they prey on Himalayan Marmot (*Marmota himalayana*), Royle's Pika (*Ochotona roylei*) and small rodents, and livestock such as Yak, Horse, Lulu Cow, Goat, Sheep (Chetri et al., 2017). The Blue Sheep became the major diet for Snow Leopard in many areas and recorded as 92% in Phu valley of Manang district (Wegge et al., 2012). They generally preferred the prey species whose average size ranges 36–76 kg such as Siberian ibex, Blue Sheep and Himalayan Tahr (Lyngdoh et al., 2014). In some cases, they hunt a larger proportion of smaller species (Lyngdoh et al., 2014), and livestock. Generally, the predation is also determined by the home range size of the Snow Leopard, and it was 1000 km^2 for Nepal's first GPS satellite radio-collared male Snow Leopard in KCA (Aryal et al., 2018).

People in rural areas of Nepal are suffering from livestock depredation (Jackson et al., 1996; Acharya et al., 2016). They reported that Snow Leopard including other carnivores such as Tibetan Wolf and Leopard are the major carnivores for livestock depredation. Increasing livestock depredation might increase the retaliatory killing of the species. However, we do not have empirical data on the diet of Snow leopard. Therefore, this study aimed to identify the diet of Snow Leopard and provide with the baseline data on whether Snow Leopard depredated livestock or wild prey species in Kanchenjunga Conservation Area (KCA).

MATERIALS AND METHODS

Study area

Kanchenjunga Conservation Area comprises 2,035 km^2, which is located in the northeastern corner of Nepal Himalayas (Figure 1). It is one of the protected areas of Nepal situated in the Taplejung district of Province 1. The area is bounded by Qomolangma National Nature Preserve of Tibet in North; Khangchendzonga National Park in Sikkim to the east and Sankhuwasabha district on the west. The elevation of KCA ranges from 1,200 m to 8,586m above the sea level. The KCA is primarily composed of glaciers and rocks (65%), and forest (24%) with negligible percentage of arable land. KCA is one major part of the Sacred Himalayan Landscape which is also one of the global biodiversity hotspots.

The KCA was established in July 1997. The management of KCA is governed by the local community. The authority to the community was handover in August 2006 for proper management and conservation of wild flora and fauna. The flora of the area are *Michelia kisopa, Aconitum spicatum, Bergenia ciliate, Choerospondias axillaris, Nardostachys grandiflora* and *Paris polyphylla, Picrorhiza scrophulariiflora, Swertia chirayita*, *Tetracentron sinense, Larix griffithiana, Ulmus wallichiana*, etc. (DNPWC, 2017). The fauna such as Snow Leopard, Musk Deer (*Moschus chrysogaster*), Red Panda (*Ailurus fulgens*), Himalayan Black Bear (*Selenarctos thibetanus*), and Himalayan Tahr (*Hemitragus jemlahicus*) are major species in KCA (WWF, 2007; Jnawali et al., 2011). People in the KCA depends on the agriculture and animal husbandry, supplemented with trade with Tibet, remittance, civil service, and income from tourism (CBS, 2011).

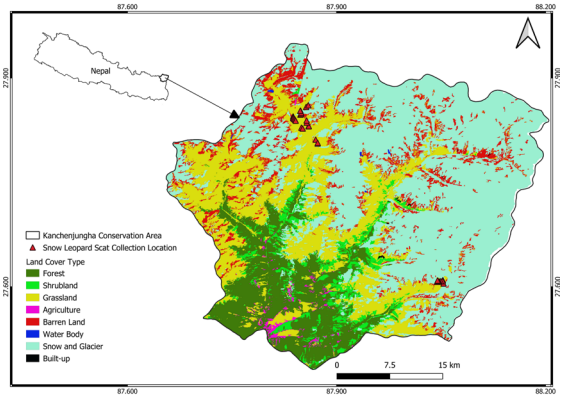

Figure 1. Study area for diet analysis of Snow Leopard in Kanchenjunga Conservation Area

METHODS

The present study was carried out in Yamphudin and Yangma of KCA, where people have been grazing their livestock, and Snow Leopard's presence was frequently reported by local people.

Scat collection

The scat analysis is a non-invasive/non destructive tool in examining the diets of carnivore species (Karanth and Sunquist, 1995). The diet of the carnivore can be identified by the remains of the prey species in the scats. (Karanth and Sunquist, 1995). A total of seven trials with an average length of 70 km was used for Snow Leopard's scat collection. The interval between these trails was more than 5 km. Three people walked at an interval of approximately 200 m along the trail between late May-June 2019 to collect the scat samples . However, the survey did not cover the terrain with steep slopes and landslides. Scats were collected from 7.00 hr to 19.00 hr during the study period and spent almost 26 days in the field. Snow Leopard's scats were also confirmed after the consultation of local herders. The samples were collected between 4,281 m to 4,960 m above sea level. Geographically, the collected samples were

from Ramzer, Yamphudin and Phaktanglung, Yangma of KCA.

We collected the nearest samples if the faecal size is varied in the region because we assumed that might be from the cubs/sub adults. In addition, we distinguished the faeces of three sympatric carnivores in KCA: Leopard and Tibetan Wolf and Snow Leopard. The Leopard's scats were distinguished from Snow Leopard by associated signs and pugmarks, size and appearance (Karanth & Sunquist 1995; Lovari et al, 2009). Leopard's scats were more coiled than Snow Leopard, shorter in distance between the successive constrictions. The Tibetan Wolf's scats are mostly found in clusters and we avoided those samples.

The location, date, approximate age (fresh-shiny and smelling and old-intact but without smelling), associated marking signs and geographic coordinates were recorded for each scat using Global Positioning System Garmin eTrex 10.

The scats were identified based on the smell of the scat, size and associated signs such as scrapes and pugmarks of Snow Leopard (Lovari et al, 2009). Only fresh scats were collected and the freshness (age) of the scats were determined based on the smell and firmness. Old, and degenerating scats were not collected for the analysis. The collected samples were sun-dried, labeled, and stored in polythene bags for further laboratory analysis (Figure 2).

Reference samples

Snow Leopard is carnivore therefore reference hair samples of potential wild and domestic prey species were prepared from dead wild animals from the field, Museum of Central Department of Zoology, Tibhuvan University; and domestic animals which were grazing in the study area. References samples from potential prey species were used to identify the food items of Snow Leopard (Figure 3). The complete tufts of hairs samples were collected from different body parts which included a representative sample of all hair types.

Slide preparation

A hair with all hair types were cleaned in water and followed by an ether-alcohol mixture (1:1) and were dried in blotting paper. Hair profile, cuticular and medullar slides were prepared according to Teerink (1991), Bahuguana et al. (2010). Long hairs were cut into two or more pieces before they keep on the glass slide. Euparal were used as mounting medium for preparing permanent reference slides, whereas paraffin oil was used as a temporary mounting medium for the routine identification of unknown hairs. The whole mount of hair tuft was placed on a clean microscopic slide and studied according to Brunner and Coman (1974). Microphotographs of the representative cross sections, medulla, and scale patterns along the length of the hairs of each species were taken at a standard magnification. The hairs present in the scat were identified from the prepared reference slides. Hair profiles, cuticular and medullary patterns were studied at the laboratory of the Central Department of Zoology Tribhuvan University, Kathmandu, Nepal.

A clean hair was placed on a glass slide, covered by a cover slip and examined under a compound microscope to record features such as root structures, color and pigments of hair. For cuticular characteristics of hair, a saturated gelatin solution was prepared by mixing granular gelatin powder in boiling water and a few grains of methylene blue were added. A thin layer of gelatin was applied to a slide using a glass rod and gelatin was allowed to cool for five minutes. The

hair was removed by forceps from the solution. The cuticular pattern appearing in the prepared gel was then examined under the microscope at 400X magnification. The medullary part of the hair comprises the shrunken cells, which are filled with air. Therefore, a dark space can be found while observing under a microscope. To remove the air spaces from the medulla of hair, the hairs (small pieces) were treated with xylene for approximately 30 minutes. The hair samples were mounted in xylene and examined under 400X microscope.

Faecal sample processing

The air-dried scats of Snow Leopard were taken to the Central Department of Zoology, Tribhuvan University's Laboratory. Each scat was soaked in warm water, washed with tap water in a fine mesh sieve and oven-dried at a temperature of approximately 60°C. The remains such as hairs, bones, hooves, teeth, claws etc. were separated for prey identification, which were eaten by Snow Leopards. Ten prey hairs randomly from each scat were used to examine the hair profile, cuticular characteristics and medullary pattern. Each sample was further cleaned with equal mixture (1:1) of ether and alcohol. Then the sample was dried with a blotting paper. The clean and dry hairs were examined visually or studied under the microscope (Figure 2). Different hair types present in each scat sample were separated and used to identify. From the visual observation major prey groups such as small and large mammals were identified based on the texture and hair color. In addition, the cross sections, whole mounts, and scale casts of each type of hair present in each scat sample were prepared and then grouped and sub-grouped based on the cross-sectional appearance and arrangement of medulla.

Figure 2. Scat of Snow Leopard from KCA field survey, 2019.

The consumed prey species were determined after making a detailed comparison of all hair structures (cross sections, medulla, and scale pattern) with the photographic key (Figure 3). The diet components were recorded as presence/absence of each prey item in a scat sample, and analysed as frequency of occurrence. Components such as stones and soil, plant parts, and Snow Leopard's hair will not be dietary items.

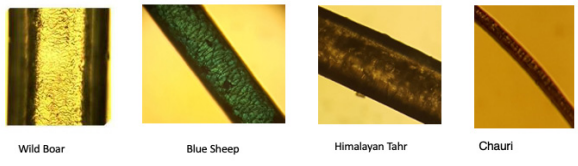

Figure 3. Images of reference samples preparation for prey identification

To confirm the livestock depredation by Snow Leopard in the study year at KCA, interview with 12 herders and one hotel owner were taken using a semi-structured questionnaire survey.

RESULTS

Altogether 39 scat samples (25 fresh with shiny and smell) were collected within 26 days from the field study in KCA (Figure 2). Nine samples were from grazing land, five samples from near to livestock grazing area/huts. Remaining 25 samples were from the high land, where livestock grazing is almost absent. All of the samples for this study were above the tree line. We assumed that these samples are from different individuals based on the size of scats. The prey remains were compared and identified with reference samples. The scat of Snow Leopards confirmed the Blue Sheep (90%) is the only one prey species for diet for Snow Leopards followed by Himalayan Tahr (8%) and livestock (Chauri: 3%) (Figure 4). During the questionnaire survey, people said there was no more livestock depredation in Ramzer, Yamphudin and Phaktanglung, Yangma of KCA in this year.

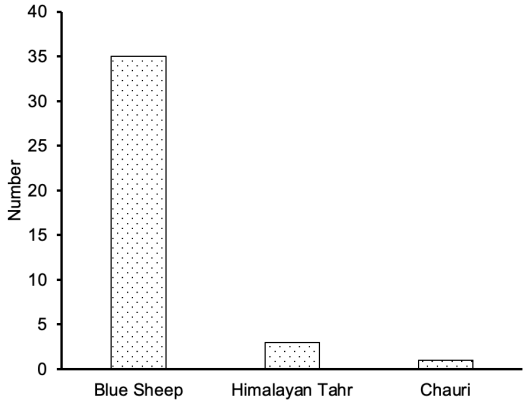

Figure 4. Number of prey species found on the scat of Snow Leopards

DISCUSSION

The scat samples were from two major habitats: Yamphudin and Yangma, where KCA deployed camera traps in collaboration with WWF Nepal. GPS Collaring on Snow Leopard in KCA has been started since November 2013, and till date altogether four Snow Leopards were collared (KCA, 2018). In most of diet studies of Snow Leopard, Blue Sheep is the major diet (see 92% in Phu Valley: Wegge et al., 2012; 63% in Central Himalaya: Aryal et al., 2014), and in this study scat of Snow Leopards confirmed the Blue Sheep is the only one prey species for diet for Snow Leopards followed by Himalayan Tahr and livestock.

During the study period we did not find any livestock depredation in this year (Finjo Sherpa, Phaktanglung-7, Yangma, Personal Communication). The appearance of Yak and Chauri's as a diet in one scat sample might be due to depredation of this livestock in another place. It might be possible due to its larger home range size (see 1000 km^2 for Nepal's first GPS satellite radio-collared male Snow Leopard in KCA: Cited in Aryal et al., 2018).

In conclusion, the major diet of Snow Leopards is natural prey species i.e., Blue Sheep. People have positive attitudes towards Snow Leopard conservation because they are less suffering from Snow Leopard. Therefore, we recommend increasing the prey species population in the wild to minimize the conflict between Snow Leopard and human in KCA.

ACKNOWLEDGEMENTS

We would like to thank the Kanchanjunga Conservation Area Office, Taplejung for providing financial support and research permission for this research. We thank the Central Department of Zoology, Tribhuvan University, Kirtipur, Kathmandu for providing the laboratory facilities, and Sandeep Regmi for his assistance.

REFERENCES

Aryal, K.P., Acharya, H.R., & Dhakal, Y. (2018). *Interaction between Snow Leopard and Tibetan Wolf in Kanchenjunga Conservation Area, Nepal.* Kanchenjunga

Conservation Area Office, Taplejung, Nepal.

Aryal, A., Brunton, D., Ji, W., Karmacharya, D., McCarthy, T., Bencini, R., & Raubenheimer, D. (2014). Multipronged strategy including genetic analysis for assessing conservation options for the snow leopard in the central Himalaya. *Journal of Mammalogy,* 95(4), 871-881

Aryal, A., Shrestha, U.B., Ji, W., Ale, S. B., Shrestha, S., Ingty, T., Maraseni, T., Cockfield, G., & Raubenheimer, D. (2016). Predicting the distributions of predator (snow leopard) and prey (blue sheep) under climate change in the Himalaya. *Ecology and Evolution*, 6: 4065-4075.

Bahuguana, A., Sahajpal, V., Goyal, S. P., Mukherjee, S. K., & Thakur, V. (2010). *Species Identification from Guard Hair of Selected Mammals: A Reference Guide.* Wildlife Institute of India, Dehradun, India.

Brunner, H., & Coman, B. J. (1975). *Identification of mammalian hairs.* Inkata Press, Victoria.

CBS. (2011) *Nepal Living Standards Survey 2010/11. Statistical Report.* Central Bureau of Statistics, Kathmandu, Nepal.

Ceballos, G., Ehrlich, P. R., Barnosky, A. D., García, A., Pringle, R. M., & Palmer, T. M. (2015). Accelerated modern human–induced species losses: Entering the sixth mass extinction. *Science advances,* 1(5), e1400253

Chetri, M., Odden, M., & Wegge, P. (2017). Snow leopard and Himalayan wolf: food habits and prey selection in the Central Himalayas, Nepal. *PLOS ONE*, 12: e0170549.

DNPWC. (2017). *Snow Leopard Conservation Action Plan (2017-2021).* Department of National Parks and Wildlife Conservation, Kathmandu, Nepal.

Hussain, S. (2003). The status of the snow leopard in Pakistan and its conflict with local farmers. *Oryx,* 37(1), 26-33

IUCN 2020. The IUCN Red List of Threatened Species. Version 2020-1. <https://www.iucnredlist.org. Accessed on 12 March 2020.

Jackson, R. M., Ahlborn, G. G., Gurung, M., & Ale, S. (1996). Reducing Livestock Depredation Losses in the Nepalese Himalaya. *Proceedings of the 17th Vertebrate Pest Conference* (eds. R. M. Timms & A. C. Crabb), 1–12. University of California, Davis, USA.

Jnawali, S. R., Baral, H., Lee, S., Acharya, K., Upadhyay, G., Pandey, M., & Griffiths, J. (2011). *The status of Nepal mammals: the national red list series.* Department of National Parks and Wildlife Conservation, Kathmandu, Nepal.

Karanth, K. U., & Sunquist M. E. (1995). Prey selection by tiger, leopard and dhole in tropical forests. *Journal of Animal Ecology,* 64: 439-450.

Katuwal, H.B., Sharma, H.P., Shaner, P.J.L., Gurung, R., Thapa, V., Magar, T.G., Gurung, T.B., Parajuli, K., Gurung, M.B., Basnet, H. and Koirala, S., Ghimire, M. S., Yadav, S., Belant, J. L. & Shah, K. (2018). Updating spatial information of 27 mammal species in Nepal. *The Journal of Animal & Plant Sciences, 28*(6), 1735-1745

Lovari, S., Boesi, R., Minder, I., Mucci, N., Randi, E., Dematteis, A., & Ale, S. B. (2009). Restoring a keystone predator may endanger a prey species in a human-altered ecosystem: the return of the snow leopard to Sagarmatha National Park. *Animal Conservation,* 12(6), 559-570

Lyngdoh, S., Shrotriya, S., Goyal, S. P., Clements, H., Hayward, M. W., & Habib,

B. (2014). Prey preferences of the Snow Leopard (*Panthera uncia*): regional diet specificity holds global significance for conservation. *PLOS ONE,* 9: p.e88349

McCarthy, T., Mallon, D., Jackson, R., Zahler, P., & McCarthy, K. (2017). *Panthera uncia*. The IUCN Red List of Threatened Species 2017: e.T22732A50664030. http://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T22732A50664030.en. Downloaded on 04 July 2019.

MoFSC. (2017). *Snow Leopard and Ecosystem Management Plan (2017-2026).* Ministry of Forests and Soil Conservation, Kathmandu, Nepal

Nowell, K., & Jackson, P. (eds.) (1996). *Wild cats: status survey and Conservation Action Plan.* Gland, Switzerland.

Oli, M. K., Taylor, I. R., & Rogers, D. M. (1993). Diet of the snow leopard (*Panthera uncia*) in the Annapurna Conservation Area, Nepal. *Journal of Zoology,* 231(3), 365-370

Ripple, W. J., Estes, J. A., Beschta, R. L., Wilmers, C. C., Ritchie, E. G., Hebblewhite, M., Berger, J., Elmhagen, B., Letnic, M., Nelson, M. P., & Schmitz, O. J. (2014). Status and ecological effects of the world's largest carnivores. *Science,* 343:1241484.

Teerink, B. J. (1991). *Hair of West-European Mammals.* Cambridge: Cambridge University Press.

Wegge, P., Shrestha, R., & Flagstad, Ø. (2012). Snow leopard Panthera uncia predation on livestock and wild prey in a mountain valley in northern Nepal: implications for conservation management. *Wildlife Biology,* 18: 131-142.

WWF. (2007). *Sacred Himalayan Landscape in Nepal: Understanding the Changes in Livelihoods Assets with Locals: a Case Study from Kanchenjunga Conservation Area Project.* World Wildlife Fund Nepal, Kathmandu, Nepal.

WWF. (2020) *Living Planet Report 2020 - Bending the curve of biodiversity loss.* Almond, R.E.A., Grooten M. and Petersen, T. (Eds). Gland, Switzerland.

Received Date : 2021/05/15
Accepted Date : 2021/09/11

DOI: http://doi.org/10.3126/zooj.v6i1.58698