Project Update: October 2018

Introduction

Nepal is one of the richest countries in biodiversity owing to its greatly varied and unique geographical, geo-morphological, ecological, climatic condition and altitudinal variation with distinct flora and fauna (Bhattarai & Vetaas, 2003). It occupies the most diverse ecosystem in the world indicating the unique habitat of wild flora and fauna. Wolves are once most widely distributed terrestrial mammals (carnivore) in the Northern hemisphere. Worldwide approximately 13 subspecies of Grey-wolf (*Canis lupus*) are recognized (Habib *et al.,* 2013). Among them, Himalayan wolf (*Canis lupus chanco)* is the most ancestral originally inhabiting in upper mustang was found to be distributed from the central Asia across the Himalaya and Trans-Himalaya region of India, Tibet and Nepal to the Northern part of Mongolia and Korean peninsula (Subba *et al.,* 2017; Sharma *et al.,* 2004; Chetri *et al.,* 2016). Himalayan wolf *(Canis lupus chanco)* is one of the least known mammals and studies have confirmed that it is a genetically unique population drifted from the general wolf clade for quite some time ago (Chetri *et al.,* 2016). The wolf is listed as the "Critically endangered" mammal species in Red list of mammal species in Nepal (Jnawali *et al.,* 2011), whereas it is least concern category in the world scenario. The wolf that are found in India, Tibet, Nepal, Bhutan and Pakistan are enlisted in the CITES (The Convention on International Trade in Endangered Species of Wild Fauna and Flora) as Appendix I species (Shrotriya *et al.,* 2012). In Nepal wolves are under protection by National Parks and Wildlife Conservation Act 1993 as priority protected species.

Annapurna conservation area (28°33'51"N, 83°19'52"E) IUCN category: VI is the largest protected areas in Nepal with an area 7,629 km^2 situated at western development region, established in 1992 AD and managed by National Trust for Nature Conservation (NTNC) practiced with peoples' participation. It ranges in altitude from 790m to Annapurna I at 8,091m above mean sea level. It bonded by the dry alpine desert of Mustang and Tibet (China) in the north with world's deepest river gorge (KaliGandaki Gorge) and a valley with fossils from the Tethys Sea dating 60 million years ago. The region holds world's largest rhododendron forest, Ghorepani; Tilicho Lake located in Manang north of Annapurna Massif, is the world's highest altitude fresh water lake (GoN/UNDP, 2016).

Climate

The areas are rich in trans-Himalayan cool and semi-arid with an average precipitation 250- 400mm and fall under the rain shadow area of Annapurna and Dhaulagiri ranges. It experiences sharp seasonal differences in temperature and rainfall. Since the area lies in the rain shadow region it receives very little rainfall estimated less than 200 mm and known as the cool desert of the country. The climate of upper mustang is generally dry with strong winds and intense sunlight. As recorded by National Trust for Nature Conservation in 2008, the maximum temperature in the region was recorded in summer 26°c whereas winter is very cold and the temperature freezes to as low as -20°c. The region has three important bio-climatic zone i.e. cold temperature, alpine climate and tundra climate are categorized with respect to the elevation of <3000m, 3000m-4500m and >4500m respectively.

Soil characteristics

The district has four different soil characteristic and soil type zones according to the soil texture based on Land System Map prepared by Land Resource Management Plan (LRMP). The area is highly dominated with the past glaciated mountainous terrain followed by the alluvial plains. Major soil types distribution comprises fragmental loamy, loamy skeletal, river and loamy whereas the fragmental loamy soil is highly unearthed throughout the area.

Land use land cover type

The status of land use land cover (LULC) in Upper Mustang is highly occupied by barren areas followed with grassland. Most of the western part of the region is covered with the snow/ice. The studies carried on Land Use Land Cover Change shows that the area has remarkable decrease in snow/ice and sandy/sediments covers are owing to occasional flood havoc and landslide events. Since the area is dominated with the fragile soil structure there is high susceptible to soil erosion and rapid change in the land use land cover.

Biodiversity

Mustang is rich in both temperate and trans-Himalayan biodiversity. The region is home of many rare and endangered flora and fauna. The biodiversity of the mustang encompasses five species of zooplankton, seven nematode species, two Mollusca species, one Annelida species, 25 insects' species (7 aquatic and 18 butterfly species), one spider species, 11 amphibian species, eight lizards, 105 birds and 29 mammals. Mustang holds the most elusive mountain mammals like Himalayan wolf *(Canis lupus chanco)*, snow leopard *(Uncia uncia)*, and birds like Tibetan Sand Grouse *(Syrrrhaptes tibetanus)*, Bearded vulture *(Gypaetus barbatus)* and Eurasian Eagle Owl *(Bubo bubo)*. Among the list of protected species as per the National Parks and Wildlife Conservation Act, 1973 (2029 BS) six of the species from the Upper Mustang are included in different threat categories of the IUCN Red Data Book (GoN/UNDP, 2016) such as Himalayan wolf is one of them.

Mustang is also recognized as the region of medicinal and aromatic plants with very high economic and ethno medicinal value. Local people use those number of plants for food, spices, fiber, medicine, fuel, dye, tannin, gum, resin, religious purpose, roofing materials, handicrafts and so on. Studies have revealed that the region holds over 200 species of Non- Timber Forest Products (NTFPs)/Medicinal and Aromatic Plants (MAPs) leaving the space of more exploration and identification. Local Amchis (traditional healers) uses around 72 species of medicinal plants to treat 43 human ailments. Similarly, Cottonwood poplar *(populus deltois)* is found nearby the agricultural farm and settlement areas.

Study site (Intensive study area)

Study area **[Fig.1]** located in high Himalayan region with distinct of geographical structure highly occupied by fragile mountain. This area is less susceptible from the urbanization. Upper mustang covers an approximately 2076.56 Km^2 areas with two Rural Municipality Lo-Mangthang and Lo-Ghekar Damodar Kund holding 1899 and 1423 population respectively, which is extended to the southern China to the north and neighboring Dolpa district to the west. These areas have an unmated and amazing piece of land enriched by natural wonders like the breath catching views of Himalayas, river fountains, lake and diversity of wild flowers and animals. Majority of the areas are covered with dry alpine desert where there is number of

grassland accessible for the livestock grazing and makes suitable habitat for the wild predators and prey ungulate counting the other small wild flora and fauna.

The biological diversity of the area equally resembled by its cultural diversity. The majority of local inhabitants of the areas are Thakali, Loba and Gurung; Tibetan origin are the most dominant in the north followed by Magar, Brahamin, Chhetri and other occupational caste comparatively smaller number in south who rely on their own rituals, speaks their own dialect and have unique culture and traditions (CBS, 2012). Majority of the People in the study site believes in Buddhism. Livestock herding is one of the key economic activities supporting agriculture, tourism and Yartsagumbu (*Ophiocordyceps sinensis*) trading in the north. The livestock grazing in the areas highly depend on high grassland with rotational grazing practice and most of the livestock are kept in open sky in the night enclosed with loose stone wall. It has been unique natural, cultural, and geographical wonders making it the most sought-after destination in Nepal.

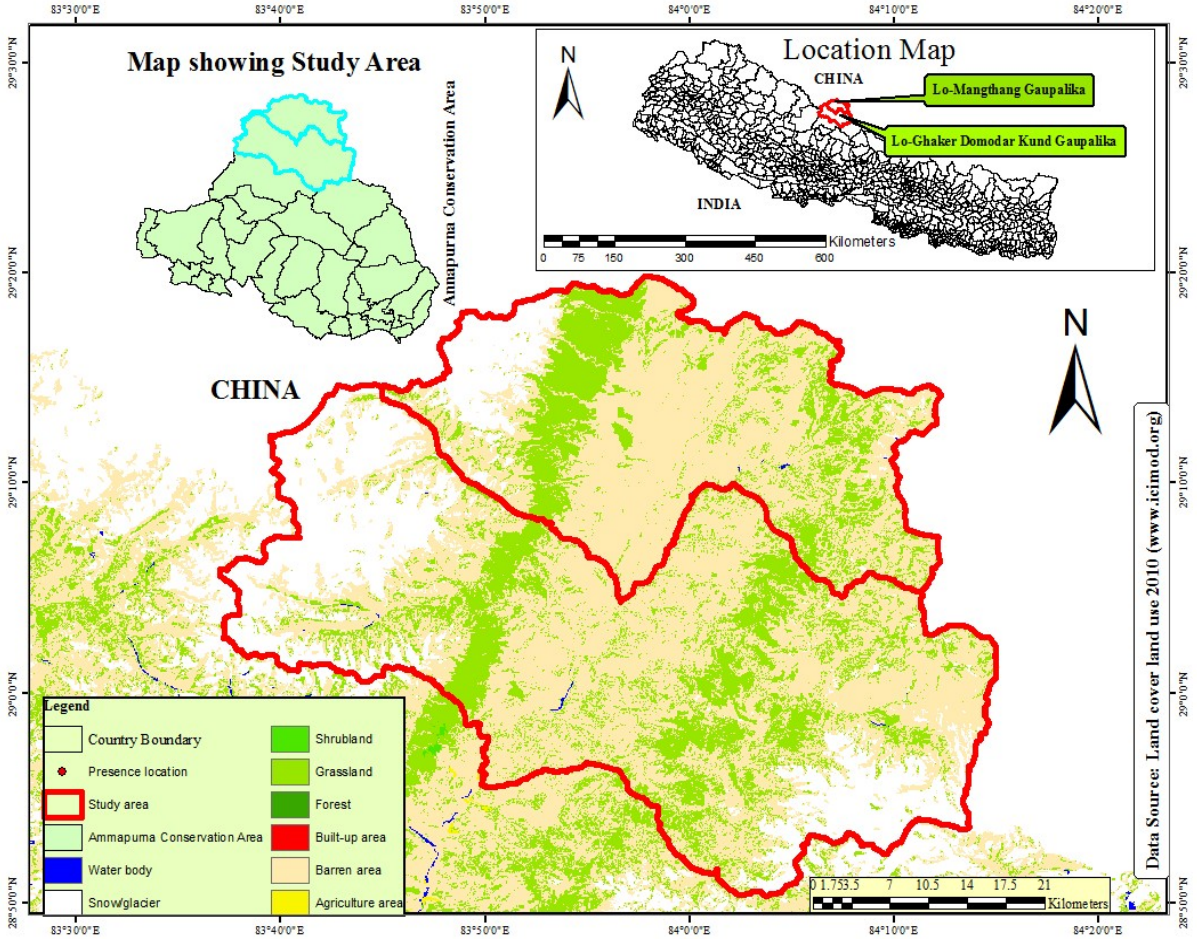

Fig 1: Map showing two rural municipality of Upper Mustang, Annapurna Conservation Area, Nepal.

Objectives of the project:
Interestingly, during my B.Sc. Project paper work in 2016, several people used to ask about the existence of wolves in my study area (Neshyang valley, Manang, Annapurna Conservation Areas which had driven me to this research and compelled me to read more about the species in many articles and published papers which showed that wolves are inhabiting in these areas. On the basis of that, I wanted to know the answer of the following research question since it is very new and findings of this research will be instrumental in future conservation planning being a baseline information.

Research question:

- How large the extent of potential habitat for recolonization of Himalayan Wolf in ACA?
- What are the most important factors for Himalayan wolf potential habitat in ACA? Having said, the study will provide the baseline information on the status distribution and its maximum potential habitats in the Nepalese Himalayas. Finally, my major objectives are documented below:
    1. To study occupancy distribution of recolonized Himalayan wolf in Upper Mustang, Annapurna Conservation Area, Nepal.
    2. To map the potential habitat of recolonized Himalayan wolf in Upper Mustang, Annapurna Conservation Area, Nepal.

Materials and Methods:

A. Pilot Field Survey
The reconnaissance survey was conducted during the month of June 2018. The informal and formal group discussion with herdsmen and conservation officials of two rural municipality was conducted. During the primary survey, semi-structured questionnaire was piloted. In consultation with the herdsmen and key informant (i.e. Conservation staff, local people who have interest in wildlife conservation) and the initial analysis of the field data the participatory map was prepared indicating the availability of wolf throughout the study areas. On the basis of perceived information different strata of occurrence possibility areas were located on the prepared map.

All the mapping process was worked in ArcGIS. To map the study area, shape file (.shp) of the country was downloaded from the Survey Department official website which was compiled by the National Geographic Information Infrastructure Programme (NGIIP) then the core study areas were extracted i.e. two rural municipality of Upper Mustang (Lo- Mangthang and Lo-Ghaker Damodar Kund). A fishnet grid was developed with 2*2 square grid cells throughout the study area that account almost 589 square grids **[Fig.2]**.

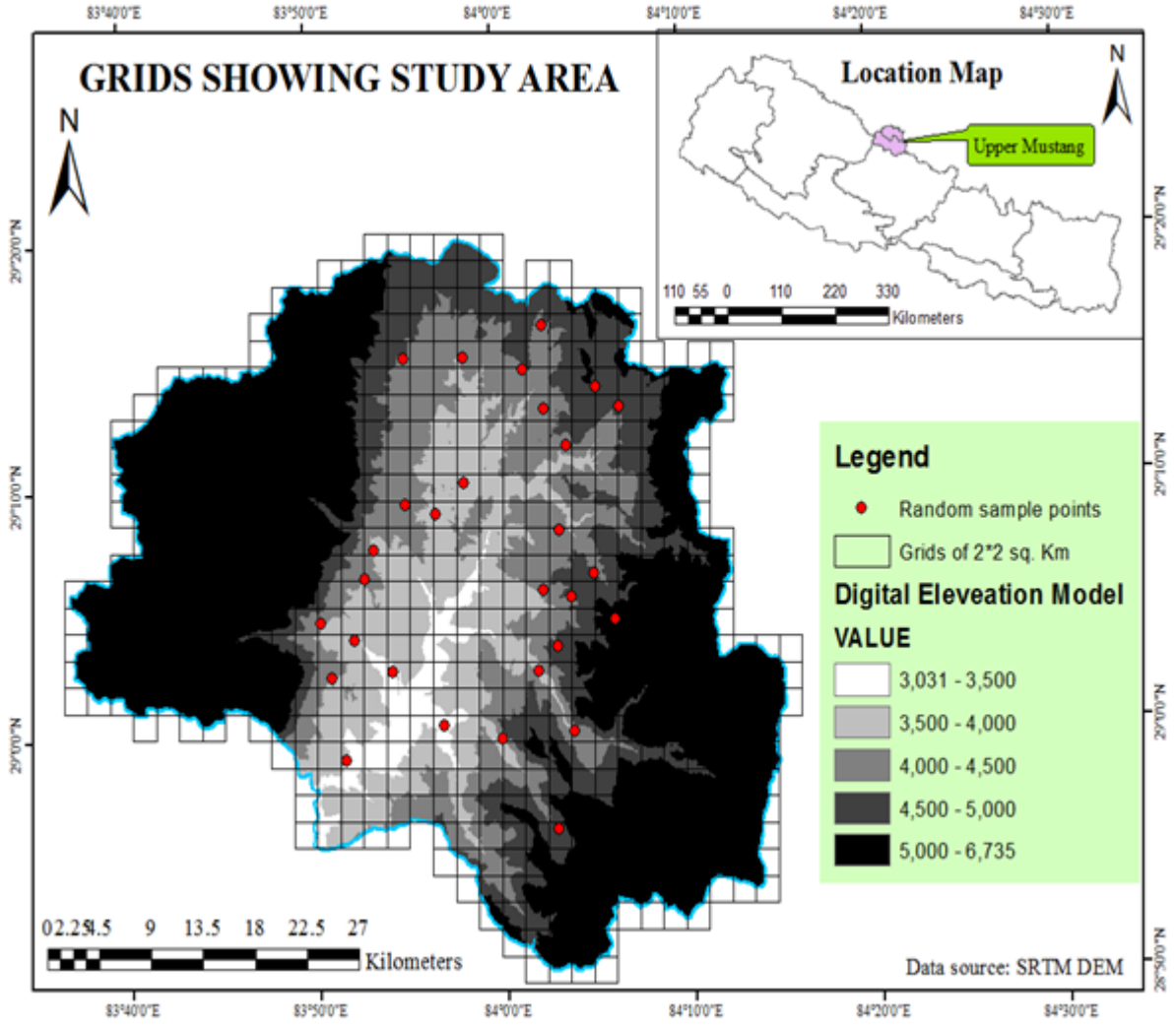

Fig 2: Study grids of 2*2 square cells and the random sample with Himalayan wolf occurrence location.

The Digital Elevation Model (DEM) was extracted from the Shuttle Radar Topographic Mission with a resolution of 1km. Then, the prepared gridded map was corresponded with DEM with an initial categorization based on elevation. The grids corresponded with the elevation approximately 3000m to 6800m where the area between >3500m to <5500m found to be more suitable then the area was calculated. Along with the feasible study area the random sample plot was established based on which the detailed field survey was further conducted. The detailed survey was planned to cover most of the areas addressing different geographical and ecological habitat which are susceptible to be potential perceived from the primary database.

The occupancy estimation is one of the important concepts in ecology. Obtaining an unbiased estimator of occupancy, it is necessary to address the issue of imperfect detection, which requires conducting replicate survey at the site being sampled. In the established sampled grids stratified random sampling method was used under the predefined study areas.

During the visit direct sighting information by herdsmen, local people and the researcher were taken as high consideration for the field validation of the sample observed and collected. This information provides the strong evidence in validating the empirical record. Occupancy methods are especially useful in sign-based surveys of wolf (elusive and occurring at relatively low densities) at the landscape scale (Linkie *et al.,* 2006; Wibisono *et al.,* 2011) because they explicitly address the issue of false absences (e.g. wolf tracks may be harder to detect in a sandy area) (MacKenzie *et al.,* 2003).

B. Sign Survey and prey abundance

As shown in **[Fig.3]**, sign survey was the method used when there is absence of visual confirmation of the species and is a commonly used method for monitoring the large carnivores and determination of presence in the studied areas.

Fig 3: Shows the Himalayan wolf scat and pugmark assessed during the field visit in Annapurna Conservation Area

An underlying assumption in this study was "higher the carnivore densities, higher will be the possibility of sign in more transects." During the field visit signs of wolves **[Fig.3]** (i.e. scratches, scats, pub marks, etc.) including the kill sites and direct sighting were recorded which indicated the presence, relative distribution and indirect indices of the abundance. Direct sighting during the field visit and by herdsmen have cogitated as one of the strong evidence whereas visiting the herders who temporarily camp in the pastureland and record of their sighting the wolf, their GPS location was recorded with associated habitat features.

Result obtained till October:

Detailed field study was carried out in the months of August to September. All the record collected was from the Annapurna Conservation Area, Mustang district. During the field visit many wild flora and fauna were observed and their location were recorded. In the course of field visit, elusive mountain mammal's Himalayan wolf and Snow leopard was sighted which proves as strong evidence on inhabiting of the Himalayan wolf in the study areas.

Occupancy distribution

Calculating the suitable areas from the reconnaissance survey database it was found that 50% of the total grids were feasible for the wolf potential. The detailed field survey was conducted throughout the study area covering almost 20% of total

feasible grids. In total 2076.56 km^2 was assessed, accounting a linear distance of 187.51 km to study wolf occurrence location. During the visits 262 samples of Himalayan wolf sign including 33 footprints; 191 feces; 19 kill sites and 19 live sighting recorded (addressing herdsmen perceptions) and 1 was direct sighting **[Fig.3]** were confirmed however, 306 occurrence locations were recorded that represent other carnivores **[Fig.4]** like snow leopard inhabiting around the study areas.

Livestock kill sites were mostly found in the flat undulating grassland in busy nature such as Carex *spp*, *Kobresia spp* with *Caragana spp. Sibbaldianthe buifurca* which are largely dominated respectively.

Fig 4: Himalayan wolf (Canis lupus chanco) sighted in Dhakmar, Upper Mustang, Annapurna Conservation Area, Nepal.

Fig 5: Photograph of Snow leopard (Uncia uncia) at 29007'47"; 840 09'25" nearby Samjhong village 30m distance to water resource, Annapurna Conservation Area, Nepal.

Considering on update till October, further field work and data analysis are yet to be done. Awareness campaigns for the students/ herdsmen are still on the process. After the initial analysis of field data, the key conflict areas will be identified based on which further field studies and awareness campaign will be conducted. All the occurrence location collected during the studies reveals that the existence of Himalayan wolf in the area. Furthermore, the data analysis on potential habitat of wolf and its occurrence will be assessed by Maximum Entropy (MAXENT) model.

Reference

Bhattarai, K., & Vetaas, O. (2003). Variation in plant species richness of different life forms along a subtropical elevation gradient in the Himalayas, east Nepal. *Global Ecology and Biogeography*, *12*(4), 327–340.

CBS. (2012). National Population and Housing Census 2011(National Report). *Government of Nepal, National Planning Commission Secretariat, Central Bu Reau of Statistics*, *01*, 1–278. Retrieved from http://cbs.gov.np/?p=2017

Chetri, M., Jhala, Y. V., Jnawali, S. R., Subedi, N., Dhakal, M., & Yumnam, B. (2016). Ancient Himalayan wolf (canis lupus chanco) lineage in upper mustang of the Annapurna conservation area, Nepal. *ZooKeys*, *2016*(582), 143–156.

GoN/UNDP, H. (2016). Resource Mapping Report. District Development Committee, Mustang.

Habib, B., Shrotriya, S., & Jhala, Y. V. (2013). *Ecology and Conservation of Himalayan Wolf. Wildlife Institute of India–Technical Report No*. TR–2013/01.

Jnawali, S. R., Baral, H. S., Lee, S., Acharya, K. P., Upadhyay, G. P., Pandey, M., Amin, R. (Compilers). (2011). *The Status of Nepal's Mammals: The National Red List Series*.

Linkie, M., Chapron, G., Martyr, D. J., Holden, J., & Leader-Williams, N. (2006). Assessing the viability of tiger subpopulations in a fragmented landscape. *Journal of Applied Ecology*, *43*(3), 576–586.

MacKenzie, D. I., Nichols, J. D., Hines, J. E., Knutson, M. G., & Franklin, A. B. (2003). Estimating occupancy, colonisation, and local extinction when a species is detected imperfectly. *Ecology*, *84*(8), 2200–2207.

Sharma, D. K., Maldonado, J. E., Jhala, Y. V., & Fleischer, R. C. (2004). Ancient wolf lineages in India. *Proceedings of the Royal Society B: Biological Sciences*, *271*(Suppl_3), S1–S4.

Shrotriya, S., Lyngdoh, S., & Habib, B. (2012). Wolves in Trans-Himalayas: 165 Years of taxonomic confusion. *Current Science*, *103*(8), 885–887.

Subba, S. A., Shrestha, A. K., Thapa, K., Malla, S., Thapa, G. J., Shrestha, S. S., … Ottvall, R. (2017). Distribution of grey wolves Canis lupus lupus in the Nepalese Himalaya: implications for conservation management. *Oryx*, *51*(03), 403–406.

Wibisono, H. T., Linkie, M., Guillera-Arroita, G., Smith, J. A., Sunarto, Pusparini, W., Zulfahmi. (2011). Population status of a cryptic top predator: An island-wide assessment of tigers in Sumatran rainforests. *PLOS ONE*, *6*(11), 25931.