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Distribution, Habitat Utilization and Threats to Chinese Pangolin (Manis Pentadactyla Linnaeus, 1758) in Community Forests of Sindhuli, Nepal

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Conflicts of Interest
There are no conflicts to declare.

ABSTRACT

The Chinese Pangolin (*Manis pentadactyla*) is a unique mammal having stiff scales, body shape slender like a reptile, burrow living and highly nocturnal. It is receiving less scientific attention therefore information on its ecology, behavior, status and distribution is still scarce in Nepal. Pangolins are distributed in many districts and protected areas of Nepal but are threatened due to habitat destruction, illegal trade and lack of awareness. Thus, this research was conducted to assess the distribution, habitat utilization and threats to Chinese Pangolin in Mahabharat and Chure community forests of Sindhuli district. The primary data were collected by using the methods adopted in National Pangolin Survey, Nepal (2016). The sample size for scheduled questionnaire survey was calculated by using the formula given by Krejice and Morgan in 1970. The secondary data were collected from the DFO, Sector forest office and community forest office. Through field survey within the transect of 500 meters; distribution of burrows, their geographical coordinates, slope, elevation, canopy cover, soil moisture, soil colour and texture, distance to settlement, water and road and number of ants/termites mound were recorded. A total of 348 burrows were recorded including 206 (91 active, 115 inactive) in Mahabharat Community Forest and 142 (57 active, 85 inactive) in Chure Community Forest. The elevation range of species was from 1400 m to 1700 m with maximum number of burrows at slope range of 30^{o}-40^{o} in Mahabharat community forest. However, in Chure community forest, the elevation range of species was from 900 m to 1300 m with maximum number of burrows at slope range of 20^{0}-30^{0}. The highest frequency of burrows was recorded in brown and light yellow colour soil in Mahabharat and Chure community forest respectively. Mostly the burrows were recorded in *Schima wallichii* and *Shorea robusta* dominant forests in

Mahabharat and Chure community forest respectively. Poaching for meat and traditional medicine and habitat destruction were major threats to pangolin at the sites and their conservation status was found to be worse.

Keywords: CHINESE PANGOLIN, CHURE FOREST, MAHABHARAT FOREST, BURROWS, CONSERVATION STATUS, POACHING, NEPAL

Introduction

Pangolins are small mammals native to Asia and Africa. They belongs to the Family Manidae and order Pholidota. Pangolin word is derived from Malayan phrase, "Pen Gulling" meaning 'rolling ball', while the term Pholidota comes from a Greek word meaning 'scaled animals'. They are also known as 'Scaly Anteaters' because of their body structure and food habits. Having no teeth and an inability to chew, pangolins feed mostly on ants and termites using their long tongue to catch them. There are eight species of pangolins (Gaubert & Antunes, 2005): four species are in Asia and the other four in Africa. Asiatic species are more specialized from the African species by the presence of well-developed pinna, hairs at the base of the scales and a median row of scales that continues to the end of the tail (Heath, 1992). They are reported to occur in Nepal, Bhutan, India and Bangladesh across Myanmar to northern Indo-China and through Southern China to Hainan and Taiwan (Duckworth et al., 2008). They are found in a wide range of habitats including primary and secondary tropical forests, subtropical broadleaf and coniferous forests and tropical wet, semi evergreen and moist forests, bamboo forests, grassland, agricultural lands and marginal lands (Heath, 1992; Gurung 1996; Challender et al., 2014). Among the four species found in Asia, two are reported from Nepal (IUCN, 2016). These are Chinese Pangolin (*Manis pentadactyla*) and Indian Pangolin (*M. crassicaudata*).

Nepal lies on the transition zone of the Oriental and Palearctic regions, therefore both the Chinese and Indian species are found here (Shrestha, 1981). They are distributed in Kathmandu, Bhaktapur,Makwanpur, Sindhupalchowk, Baglung, Dhading, Kavre, Ramechap, Sindhuli, Gorkha and Bardia (Chalise, 2008). They are also distributed in Annapurna Conservation Area, Makalu Barun National Park and Shuklaphanta National Park and also from districts of Taplejung, Illam, Panchtathar (Majupuria & Majupuria, 2006). The study made by Kaspal (2008) showed its presence in community forest of Suryabinayak range post, Bhaktapur. Similarly, the study of Suwal (2011) showed its occurrence in private and community forests of Balthali, Kavre. Chinese Pangolin is more widespread in Nepal compared to Indian Pangolin. The latter is limited to Chitwan, Parsa, Bara, Surkhet, Banke, Bardia and Kanchanpur districts of Nepal (Basnet et al., 2016).

Pangolin trade and threats

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) reports that pangolins are the most trafficked and poached mammal in the world. According to Zhang (2008), the utilization is prime threat to China's *M. pentadactyla* population. Apart from harvest pressure, inherent characteristics of the species, monotypic taxonomy, low reproductive rate, poor defense, highly specialized food and habitat loss are major causes of deterioration of population of Chinese Pangolin. It is significant that this species is reported to be an easier species to locate and hunt in the wild (Newton et al., 2008). This illegal trade occurs despite pangolins having protected status under national legislation throughout their ranges in addition to being listed in CITES Appendix I, with an annotation of zero export quotas for the four Asian species, which prohibits international trade in wild-caught specimens for commercial purposes.

The Chinese Pangolin has been intensively hunted for its meat, which is considered a delicacy, as well as for its skin and scales, which have been used to scratch mosquito bites, due to their supposed antiseptic properties, or ground into powder which is believed to have aphrodisiac properties and an ability to cure for skin diseases (Heath, 1992). The primary threat to this species are hunting and poaching, both targeted and untargeted, for local, i.e. national level use as well as international trade, which is now driven largely by market demand in China, and this species is evidently subject to very heavy collection pressure across much of its range (CITES, 2000; Challender, 2011). As has occurred historically, exploitation for consumptive, medicinal and spiritualistic reasons locally continue to take place (CITES, 2000), but evidence suggests local use is often forgone in favor of entering animals into national and international trade given their high monetary value (Newton et al., 2008).

Materials and methods

Study Area

The study was carried out in Mahabharat and Chure Community Forest of Sindhuli District, Central Nepal. Sindhuli covering 2,491 km², is a part of Province No. 3 and it is one of the 77 districts of Nepal. Sindhulimadhi Kamalamai is the district headquarters.

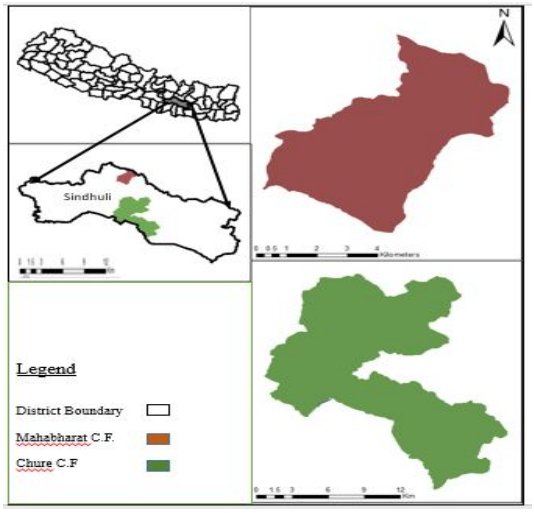

Figure 1: Map showing the study area

Methods

Primary Data Collection

For the primary data collection, the method adopted in National Pangolin Survey, Nepal, (2016) was followed.

Field methods

Reconnaissance

A preliminary survey was carried out prior to the field survey in Sindhuli to conceptualize the situation and to identify the potential sites of Chinese Pangolin. The survey included discussion with District Forest Office (DFO) authorities, Sector Forest Office (SOF), Key Informants, Community Forest User Groups (CFUGs), local people and review of relevant literature.

Focus Group Discussion

Two focus group discussions were carried out separately in two community forests with Community Forest User Groups (CFUGs) and other local people focusing especially on people who frequently visit the forest areas, to assess the information on the status and distribution of Pangolin, conservation status, social belief, perception of local people and threats to Pangolin.

Key Informant Survey

The DFO staff, Community Forest Secretary, local elite persons, school teachers and local elderly persons were consulted as key informants to gather general information about the status and distribution of the species, poaching, local beliefs, conservation status and other important information was collected through direct and/or indirect open ended and close ended questions. Snowball technique was adopted to select the key informants and checklist was prepared for the survey.

Schedule Survey

To assess the more information on threats, conservation status of pangolin and perception of locals about the

species scheduled questionnaire with different personnel, local people and CFUGs was performed. A semi-structured questionnaire was prepared. The number of respondents were calculated by using the formula given by Krejice and Morgan in 1970;

$$s = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)}$$

Where,

s = sample size

N = total number of households

P = population proportion

X = confidence level

d = error limit

Habitat Survey

The potential distribution sites of Chinese Pangolin as identified during group discussion and KII was then, surveyed by direct field observation. Block transect method was adopted to collect data on habitat related variables. Transect of 500 meters was laid at the site with the presence of evidences of Pangolin burrow and at the interval of 100 meters, 3 plots of 100 meter square were plotted at the beginning, in the middle and at the end of transect. The geographical coordinates of the sites and burrows (active and inactive) as well as the diameter of every burrow was recorded.

The habitat variables such as elevation, aspect, slope, canopy cover, soil moisture, soil colour, soil texture, major vegetation and distance to food source (ants/termites mound), road, water source and settlement were recorded in each plot. For threat analysis intensity of natural resource collection, grazing, trampling, fire, loping/stumps and other threats related variables were recorded from each plot.

Burrow Identification (records and measurements)

The burrows were categorized into active and inactive following the methods used by Suwal (2011):

- Active/New burrow- Fresh and loose soil, devoid of dry fodders, fresh scratches, footprints, trace of tail and pellets at the entrance of the burrow.
- Inactive/Old burrow- Compact and dry soil, burrow mostly covered with the dry fodders, spider nets and the burrows without scratch sign at the burrow's opening.

GPS coordinates of location, diameter, elevation, aspect, slope, soil type, sign of presence through burrows (Active/Inactive), pellets, footprints, scratches/digging and scales were recorded from the location of burrow.

Canopy cover, slope, elevation and soil type

The canopy cover of the vegetation within the transect was recorded using a Densiometer (Lemmon, 1957).

The canopy cover was classified as low (<25%), medium (25-50%), high (50-75%) and very high (>75%). The slope was categorized as very low (<10°), low (10°-20°), moderate (20°-30°), high (30°-40°), moderately high (40°-50°), very high (>50°). The elevation range was categorized from 900 m to 1700 m as low (900 m-1100 m), medium (1100 m-1300 m), high (1300 m-1500 m) and very high (1500 m-1700 m). Similarly, soil moisture as low (<10%), medium (10%-20%) and high (20%-30%), the soil color as red, yellow, brown (categorized as light and dark) and texture as fine, medium and coarse was noted according to visual judgment at the site.

Threats identification

The factors like grazing, fire, landslide, trampling, logging/lopping, unmanaged road construction were recorded at the site. In addition, the proximity variables as distance to nearest settlements, roads, water source, ants and termites mound were recorded to help identifying direct and indirect threats to the Chinese pangolin in the area.

Secondary Data Collection

The records and information from the DFO, Sector Forest Office and Community Forest office related to pangolin and the site were reviewed and noted. In addition, relevant references to different journals, articles, thesis and available information were reviewed.

Data analysis

All the collected data were entered in MS EXCEL 2013 and SPSS 21. SPSS 21 was used for analyzing data of questionnaire. Arc GIS 10.4.1 was used to map out the distribution of Chinese Pangolin in the study area. R-Software (version 3.4.0) was used to analyze the significant factors responsible for the distribution of burrows using Binomial distribution model and Poisson Model was used to know the important factors that influence the density of the burrows considering the total variables i.e. altitudes, transects, aspects, slope, soil, vegetation, canopy cover and distance to road, settlement, water and food (ants/termites mound) source.

Results

Distribution of Burrows

A total of 348 burrows was recorded including 206 (91 active burrows and 115 inactive burrows) in Mahabharat Community Forest and 142 (57 active burrows and 85 inactive burrows) in Chure Community Forest.

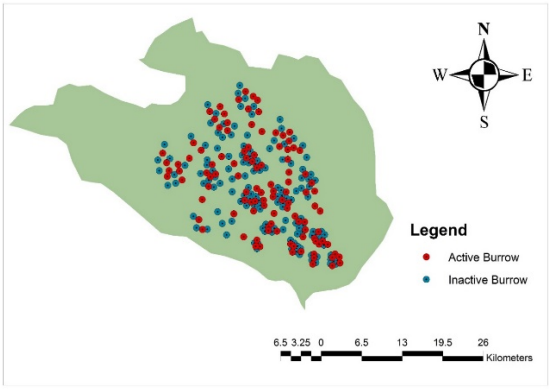

Figure 2: Distribution of Burrows in the Mahabharat Community Forest

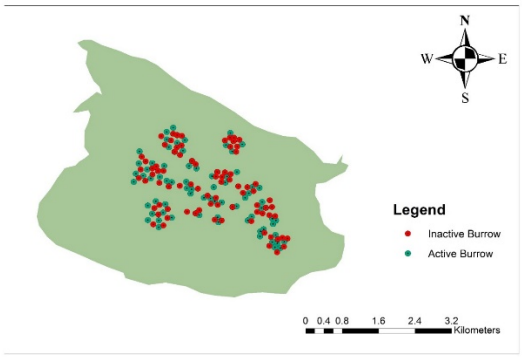

Figure 3: Distribution of burrows in the Chure Community Forest

Habitat Use

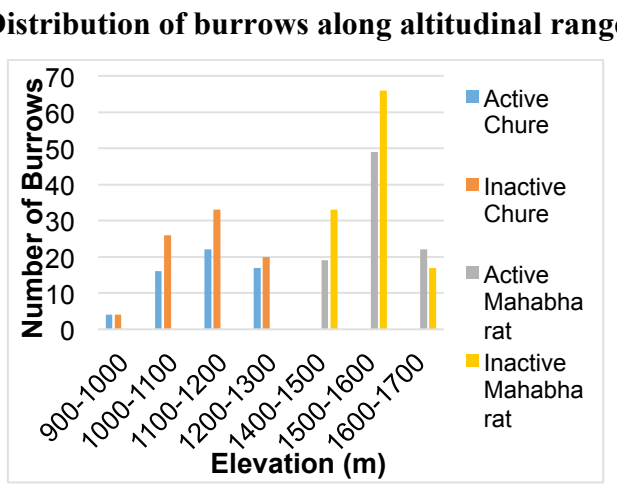

Figure 4: Distribution of burrows along altitudinal range in the study area

Distribution of Burrows with Aspect

In Mahabharat Community Forest, the active burrows were recorded in the decreasing order of aspect from Southwest (35%) > West (22%) > Northwest (14%) > South (11%) > Northeast/Southeast (5%) > North/East (4%) and the inactive burrows had similar type of aspects as Southwest (28%) > West (18%) > Northwest (16%) > Southeast/South (9%) > Northeast/North (7%) > East (6%).

However, in Chure Community Forest, the active burrows were distributed in the decreasing order of aspect

from Southwest (39%) > Northwest/West (15%) > South (8%) > Southeast (7%) > North/East (6%) > Northeast (4%) and the inactive burrows had similar type of aspects as Southwest (32%) > West/Northwest (14%) > South/Southeast (11%) > Northeast (8%) > North/East (5%).

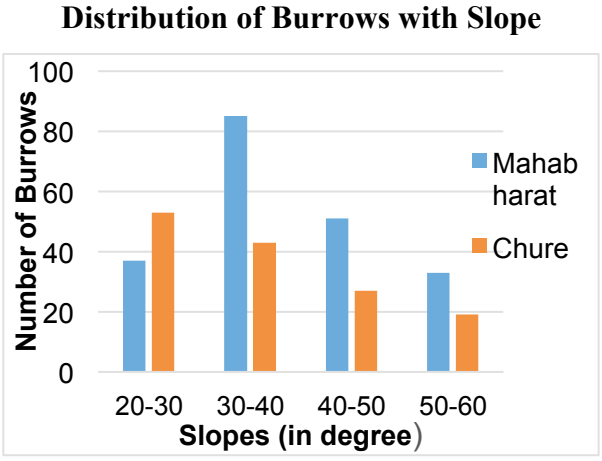

Figure 5: Distribution of burrows in different slopes

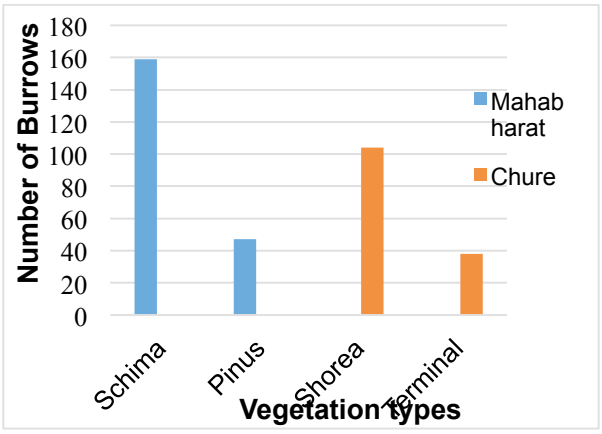

Figure 6: Distribution of burrows in different vegetation types

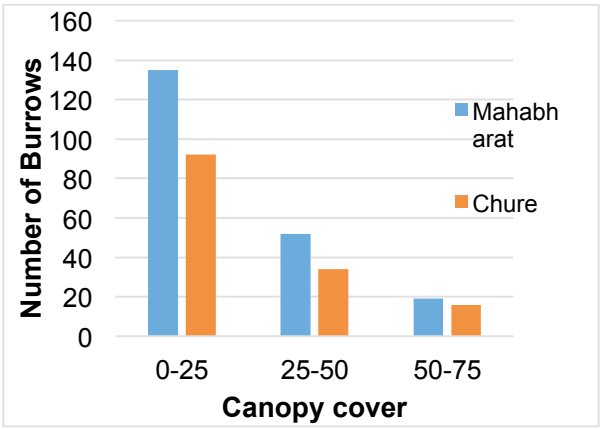

Figure 8: Distribution of burrows in different canopy cover

Distribution of Burrows with Soil Colour

In Mahabharat Community Forest, majority of the burrows were recorded from the soil with brown colour (64%) followed by red colour (20%). The least number of burrows were recorded with light brown (6%) and dark brown colour soil (10%).

However, in Chure Community Forest, highest frequency of burrows were distributed in the soil with light yellow colour (58%), and few burrows were distributed in brown colour soil (18%) which were further categorized as brown (18%), dark brown (14%) and light brown (10%).

Distribution of Burrows with Soil Texture

In both community forest, there were similar pattern of distribution of burrows with soil texture. The majority of the burrows had fine texture soil whereas very few had medium texture soil and no burrow with coarse texture soil was recorded.

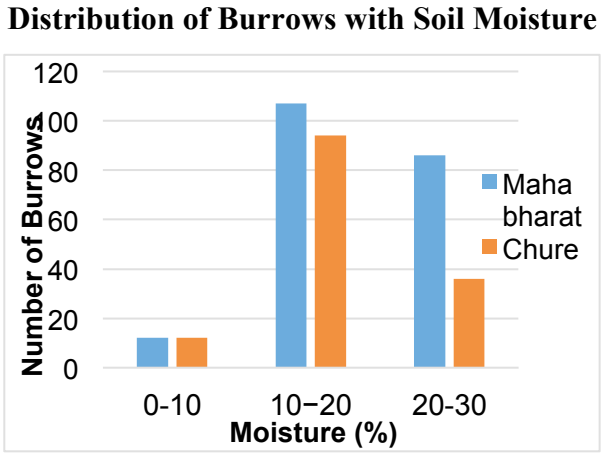

Figure 9: Distribution of burrows in different soil moisture

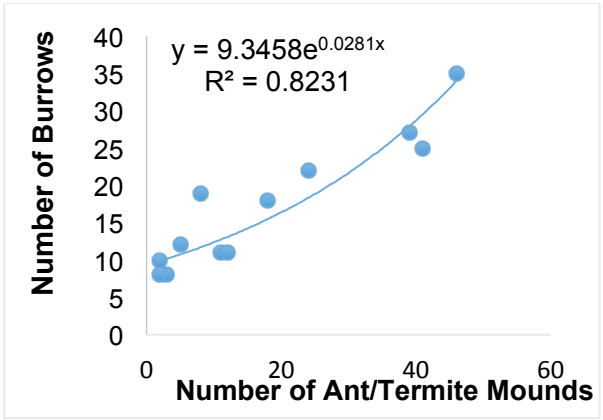

Figure 10: Distribution of burrows with the availability of food source of Mahabharat Community Forest

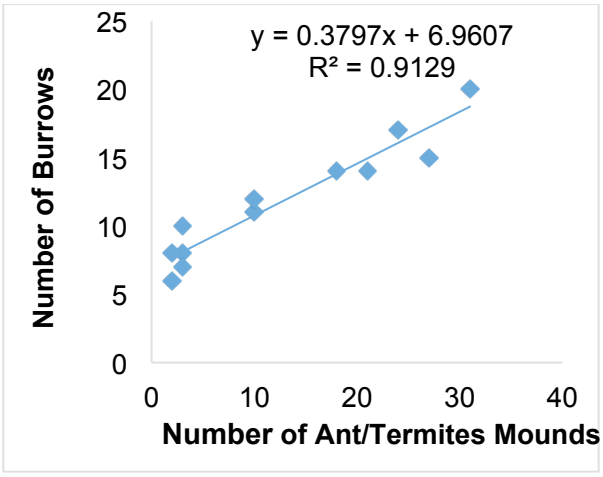

Figure 11: Distribution of burrows with the availability of food source of Chure Community Forest

Distribution of Burrows with Distance to Settlement

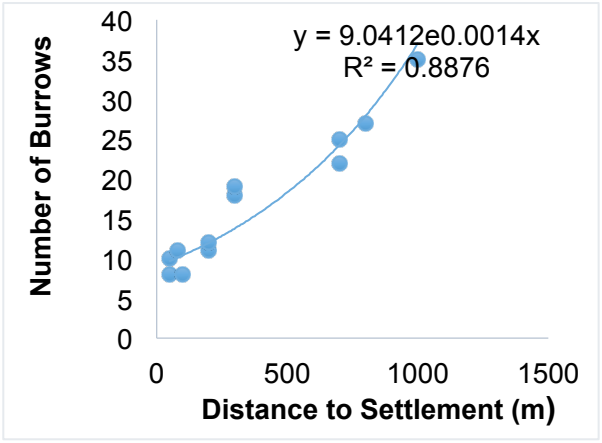

Figure 12: Distribution of burrows with the distance to settlement of Mahabharat Community Forest

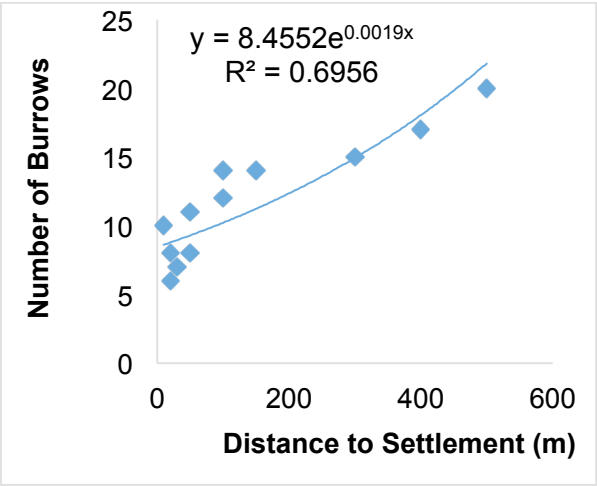

Figure 13: Distribution of burrows with the distance to settlement of Chure Community Forest

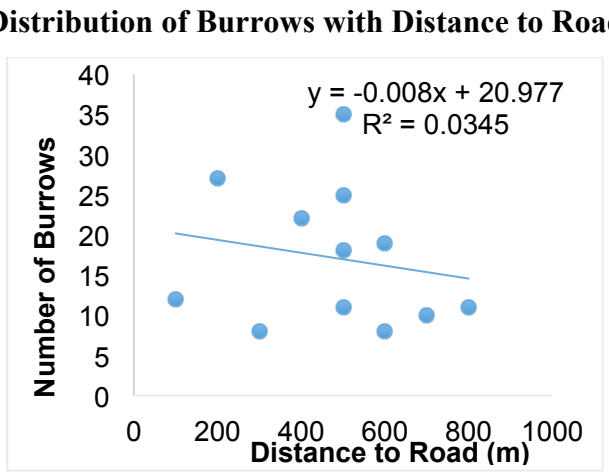

Figure 14: Distribution of burrows with distance to road of Mahabharat Community Forest

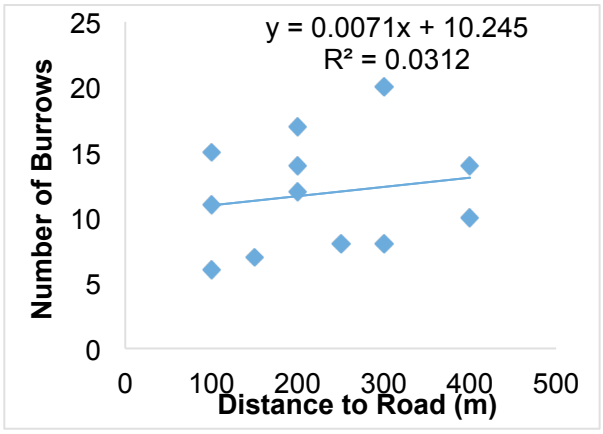

Figure 15: Distribution of burrows with distance to road of Chure Community Forest

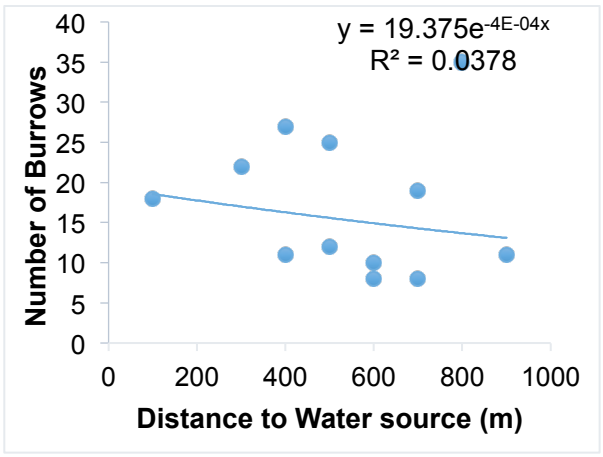

Figure 16: Distribution of burrows with distance to water source of Mahabharat Community Forest

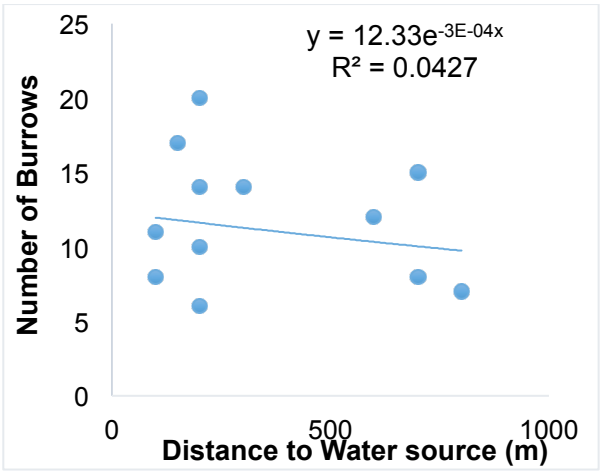

Figure 17: Distribution of burrows with distance to water source of Chure Community Forest

Factors affecting the distribution of burrows

Lower the AIC value higher is the significance of the variables.

Table 1: Significant factors affecting the distribution of burrows of Mahabharat Community Forest

S.N.	VARIABLES	AIC Value
1.	Elevation + Aspect + Slope + Canopy cover + Soil Colour + Soil Texture + Soil Moisture + Distance to Settlement + Distance to Road + Distance to Water Source + Number of Ant and Termite Mounds	213.42
2.	Elevation + Slope + Canopy cover + Soil Colour + Soil Texture + Soil Moisture + Distance to Settlement + Distance to Road + Distance to Water Source + Number of Ant and Termite Mounds	211.2
3.	Slope + Canopy cover + Soil Colour + Soil Texture + Soil Moisture + Distance to Settlement + Distance to Road + Distance to Water Source + Number of Ant and Termite Mounds	209.22
4.	Slope + Canopy cover + Soil Colour + Soil Texture + Soil Moisture + Distance to Settlement + Distance to Water Source + Number of Ant and Termite Mounds	207.35
5.	Canopy cover + Soil Colour + Soil Texture + Soil Moisture + Distance to Settlement + Distance to Water Source+ Number of Ant and Termite Mounds	206.36
6.	Canopy cover + Soil Colour + Soil Texture + Distance to Settlement + Distance to Water Source + Number of Ant and Termite mounds	205.57
7.	Soil Colour + Soil Texture + Distance to Settlement + Distance to Water Source + Number of Ant and Termite Mounds	205.16

8.	**Soil Colour + Soil Texture + Distance to Water Source + Number of Ant and Termite Mounds**	**204.29**

Table 2: Significant factors affecting the distribution of burrows of Chure Community Forest

S.N.	VARIABLES	AIC Value
1.	Elevation + Aspect + Slope + Canopy cover + Soil Colour + Soil Texture + Soil Moisture + Distance to Settlement + Distance to Road + Distance to Water Source + Number of Ant and Termite Mounds	133.22
2.	Elevation + Aspect + Slope + Soil Colour + Soil Texture + Soil Moisture + Distance to Settlement + Distance to Road + Distance to Water Source + Number of Ant and Termite Mounds	131.31
3.	Elevation + Aspect + Soil Colour + Soil Texture + Soil Moisture + Distance to Settlement + Distance to Road + Distance to Water Source + Number of Ant and Termite Mounds	129.59
4.	Elevation + Aspect + Soil Colour + Soil Texture + Soil Moisture + Distance to Settlement + Distance to Road + Distance to Water Source	128
5.	Elevation + Aspect + Soil Colour + Soil Texture + Soil Moisture + Distance to Settlement + Distance to Water Source	126.59
6.	Elevation + Aspect + Soil Colour + Soil Texture + Distance to Settlement + Distance to Water Source	125.64
7.	Elevation + Aspect + Soil Colour + Soil Texture + Distance to Water Source	124.4
8.	**Elevation + Aspect + Soil Colour + Soil Texture**	**122.64**

Factors affecting the density of burrows

Lower the AIC value higher is the significance of the variables.

Table 4: Factors affecting the density of burrows of Mahabharat Community Forest

S.N.	VARIABLES	AIC Value
1.	Distance to Settlement + Distance to Road + Distance to Water Source + Number of Ant and Termite Mounds	338.25
2.	Distance to Settlement + Distance to Water Source + Number of Ant and Termite Mounds	336.38
3.	Distance to Water Source + Number of Ant and Termite Mounds	334.58
4.	**Number of Ant and Termite Mounds**	**333.13**

Table 5: Factors affecting the density of burrows of Chure Community Forest

S.N.	VARIABLES	AIC Value
1.	Distance to Settlement + Distance to Road + Distance to Water Source + Number of Ant and Termite Mounds	227.69
2.	Distance to Settlement + Distance to Road + Number of Ant and Termite Mounds	225.69
3.	Distance to Settlement + Number of Ant and Termite Mounds	223.69
4.	**Number of Ant and Termite Mounds**	**221.77**

Conservation Status

Species Recognition, status (last 5 years) and Awareness

Out of the 174 respondents; 108 from Mahabharat Community Forest and 66 from Chure Community Forest, majority (78%) respondents knew about the species, 66% believed that the population of pangolin was decreasing over last 5 years. Similarly, few respondents responded that the population was increasing and very few responded about having no idea/no change in species population.

Majority of the respondents (81%) were aware about the poaching of the species is illegal whereas one-third respondents were unaware about its legal status.

Period of Hunting Pangolin

Majority of the respondents (32%) responded that the poaching was done occasionally; two-fourth responded no hunting as well as hunting in regular basis, whereas one-fourth responded rarely hunting of the species.

Purpose of Poaching

Majority of the respondents (54%) responded that the purpose of poaching was for meat consumption whereas, few (12%) responded the purpose was for scale (medicinal purpose) and two-third responded for both the meat and scale purpose.

Perception on Threats to Pangolin

More than half of the respondents (64%) responded that the poaching activities of pangolin for meat and scale is the main threat, also one-third responded habitat degradation and very few (4%) responded that forest fires are other threats to pangolin.

Protection of Pangolin

Majority of the respondents (76%) agreed about the protection of pangolin whereas, few (16%) had no idea regarding the importance of protection and very few (8%) disagreed about the protection concept.

Effective Conservation Measure

Majority of the respondents (72%) responded that the best measures for the conservation of the species was

awareness program whereas, few (20%) responded the enforcement of strict law and very few (8%) responded the information about the species was the effective conservation measure.

Threats to Pangolin (Direct Field Observation)

Table 6: Threats to Chinese Pangolin observed in Mahabharat Community Forest

Threats	Number of transects	Frequency (%)
Grazing	8	66.67%
Trampling	7	58.33%
Road Construction	4	33.33%
Logging	3	25%
Fire	2	16.67%
Landslide	0	0

Table 7: Threats to Chinese Pangolin observed in Chure Community Forest

Threats	Number of transects	Frequency (%)
Grazing	10	83.33%
Trampling	8	66.67%
Road Construction	4	33.33%
Logging	5	41.67%
Fire	2	16.67%
Landslide	1	8.33%

Discussion

Pangolins are burrowing mammals and their presence and absence is noticed by the burrows where they inhabit. The study clearly revealed that the distribution pattern of burrows of Chinese Pangolin in two study sites were clumped which contrasts with the observation of Suwal (2011), who recorded non-uniform distribution pattern of burrows. This might be due to the uneven distribution of resources, social interactions between individuals and inability of offspring to independently move from their habitat. Many biophysical factors could play roles on the distribution of burrows of the pangolin. The steep slopes of more than 60° or lower than 30° shady slopes, a distance less than 100 m of human activities and excessive canopy density (71-100%) or too low (0-30%) are avoided by pangolins but they prefer burrow at south facing entrances (Wu et al., 2003b). In addition, their frequent observation in the forest patches might be associated with the availability of ants and termites in such human dominated landscape.

Habitat selection is a process that individual or colony of animals look for a relatively suitable habitat. Pangolin selects different habitat types with varying elevation, aspect, slope, canopy cover, soil colour, soil texture and soil moisture. Considering elevation as a factor, in Mahabharat community forest, burrows were recorded in elevation ranging from 1400 m-1700 m, where majority of burrows were recorded at an elevation ranging 1500 m-1600 m followed by 1400 m-1500 m, whereas very less burrows were recorded at elevation ranging 1600 m-1700 m. However, in Chure community forest, burrows were recorded in elevation ranging from 900 m-1300 m, where highest frequency of burrows were recorded at an elevation ranging 1100 m-1200 m followed by 1000 m-1100 m and 1200 m-1300 m, whereas very less burrows were recorded at an elevation ranging 900 m-1000 m. The less number of burrows at lower elevation range might be due to the presence of human settlement. Similarly, the reason for the low burrows at higher elevation might be due to the lesser availability of food source (ants/termites). Baral and Shah (2008) state the elevation range by Chinese pangolin up to 2000 m in the central and eastern region and in the lowlands and foothills of Siwalik (Churia) range and my study is also within the given range. Similarly, Chao (2001) and Chakraborty et al. (2002) have recorded the elevation range of burrows up to 2000 m. Also, according to Bhandari (2014), mostly burrows are recorded at the range of 1450-1550 m and beyond 2000 m in Nagarjun forest. In addition, Suwal (2011) recorded elevation range of the burrows from 1126 m-2406 m.

Similarly, aspects play the important role in the distribution of burrows. The highest frequency of burrows were observed at southwest aspect followed by west aspect and relatively less number of burrows were recorded in east aspect in both of the community forest. This study is very similar to the study by Gurung (1996), Acharya (2001) and Kaspal (2008) which states that the pangolins' preference to south aspect but contradicts with the study by Suwal (2011) who recorded highest proportion of burrows in east facing slopes. This might be because of the availability of; habitats mostly on east facing slopes, food source and suitable climatic condition in the sites. In another study, pangolin preferred south facing and strongly avoided north facing entrances (Wu et al., 2004). Burrows facing the sun make them easy to dig and to maintain burrow temperature in winter (Wu et al., 2003b).

From the observation it was noticed that in Mahabharat community forest, the preferred slope by the pangolin to dug burrow was 30°-40° followed by 40°-50° and 20°-30°, whereas no burrows were noticed below 10° and above 60° but very less in higher slope i.e. 50°-60°. This result shows similar results with the study by Jiang (1988) where result shows burrows dug at 30°-50° steeper slopes and slopes steeper than 60° were avoided. However, in Chure community forest, the preferred slope by the pangolin to dug burrows was 20°-30° followed by 30°-40° and 40°-50°, whereas no burrows were noticed below 10° and above 60° but very less in higher slope i.e. 50°-60°. This result shows similar with the study by Heath (1992) who recorded highest frequency of burrows at the slope between 20°-40°.

Regarding vegetation association of Chinese Pangolin, in Mahabharat community forest, the highest proportion of burrows are recorded in the areas dominated by *Schima wallichii* followed by *Pinus roxburghii* forest. Acharya (2001), Shrestha (2005) and Bhandari (2013) support this result of maximum burrows in Pine forest, where mostly burrows are recorded in *Schima wallichii* and Pine-Schima forest. However, in Chure community forest, the highest frequency of burrows are recorded in *Shorea robusta* dominated forest followed by *Terminalia elliptica*. This result is similar with the study by Kaspal (2009) who recorded majority of burrows in an area dominated by *Shorea robusta* dominated forest.

One of the important environmental factor for wildlife survival is the canopy cover. Chinese Pangolins are shy mammals and have poor defense action against their predators (Lui and Xu, 1981; Nowak, 1999), accordingly they require dense cover habitats to survive and protect their cubs, especially in bearing season (winter and spring). The study by Wu et al (2003) in winter in Dawuling Natural Reserve record vegetation density too high above 75% and too low, less than 30% is avoided. Likewise, Akpona et al. (2008) record the vegetation cover of the pangolin habitat to vary between 20% and 70% in the Lama Forest reserve. These studies contradicts with the observation in both of the community forests, where majority of burrows are recorded in the canopy cover of 0-25% followed by 25-50% and very less in 50-75% canopy cover. The burrows above 75% canopy cover are not recorded in both community forest. This might be because the forests are open forest and less dense due to which the canopy cover is recorded low i.e. 0-25%. In addition, according to Suwal (2011), Chinese Pangolins utilized forest and agricultural land and the maximum numbers of burrows were recorded in forest with the crown cover of 0-25%. However, this study is also similar to Shrestha (2005) study about pangolin in Shivapuri (Nagarjun) National Park where burrows were observed at open forests with less coverage. This shows if other parameters excluded there is less connection between the canopy cover and pangolins to dig their burrows i.e. in low as well as high canopy cover area. The other major factors are responsible for the habitat preference by the pangolin but not the canopy cover as this factor is responsible for only visualization of their predators about the pangolins burrow which does not be hidden completely from them as the soil expose clearly on the surface after a burrow is dug.

The observation in Mahabharat community forest, shows majority of burrows in fine texture and brown soil followed by red soil which supports with the observation by Kaspal (2008) and Suwal (2011) who observe the burrow presence in both red and brown soil. Similarly, Bhandari (2013) records higher frequency of burrows in brown coloured soil. In addition, Gurung (1996), Acharya (2001) and Shrestha (2005) state that pangolin prefer red soil. However, in Chure community forest, the highest frequency of burrows are recorded in fine texture and light yellow soil which contrasts with other observations that might be due to the low organic matters present at the study site, different species of trees which might play role in less acidity of the soil, the geological structure and the mineral or chemical contents of the soil.

In Mahabharat community forest, the total burrow density is found to be 3.4 burrows per hectare however, in

Chure community forest, the total burrow density is found to be 2.3 burrows per hectare. This study contrasts with the study by Kaspal (2008) who recorded total burrow density of 10.2/km². In addition, the burrow density recorded by Suwal (2011) was 8 burrows per hectare. This might be due to the transect area covered by the different research which resulted in different number of burrows and also due to the different environmental factors which might have caused more burrows in the other sites.

The significant factors responsible for the distribution of burrows in both of the community forest are calculated using binomial distribution model where it is observed that out of the total variables soil colour, soil texture, distance to water source and availability of food source are seen having significance effect on the burrow distribution in Mahabharat community forest however, in Chure community forest, elevation, aspect, soil colour and soil texture are observed to be the most significant factors affecting the distribution of burrows. Similarly, Poisson Model is used to know the significant factors that influence the density of the burrows. In both community forest, the availability of food source is observed to be the most significant factor for the density of burrows.

The burrows location is highly determined by the availability of ants and termites. According to the observation in both of the community forest, the areas with higher ants and termites mound had higher number of burrows. With the availability of food source, the number of burrows were observed increasing, which determines that food availability directly affects the animal distribution. In addition, the correlation between food availability and the burrow distribution showed a strong positive correlation, which signifies that food availability is a major factor for the burrow distribution. This result can be well defined by (Zahng et al., 2004), due to its food specialization and stenophagy (only eating several species of ants and termites) Chinese pangolin is a susceptible species. In addition, (Allen & Coolidge, 1940; Heath & Vanderlip, 1988) explained that in temperate areas Chinese pangolins spend in deep burrows during winter months. The burrows are dug near the ant/termite mounds that helps in providing food source for longer time and in case of China, close correlation was observed between the distribution of termite and distribution of burrows, which are assumed the major diet component.

Likewise, the other factors like the distance to road, settlement and water source too have influence in burrow distribution. The observation showed that distance to road does not have significant effect on burrow distribution in both community forest. This might be because only the main road/highway was taken into concern but the foot trails were not recorded. In addition, the residential areas were more concentrated near to the road due to which less impact to the pangolin and its burrows were observed. Another factor taken into account was the distance to water source, which is also an important factor for the species. The distribution of burrows as observed in both community forest were not strongly correlated with the water source but less relation was observed which proves that water source is also an important factor for the species. In addition, settlement was also a strongly correlated factor for the distribution of burrows in both

study sites. The observation showed that farther the settlement area higher the burrows availability was observed which explains that human encroachment is a threat to the pangolin due to which the species dug their burrows far from the settlement areas. This observation shows similar to the study by Gurung (1996) who observed that a contributing factor in the decline of *M. pentadactyla* is the encroachment of large human settlements into the preferred habitat of this species in Nepal. In addition, in Taiwan, (Chao, 1989; Taiwan Forestry Research Institute *in litt*. 1992) reported that habitat destruction, especially by insecticide spraying; the Chinese pangolin is under pressure.

Majority of the locals had seen pangolin, which shows that most of the people were familiar about the mammal. Those who were familiar with the mammal responded that the population of pangolin has been decreasing over the last five years. Most of the locals especially the people who visit the forest frequently responded that the number of fresh burrows were declining than that of before and the encounter of the species was rare. This shows the decline in population of pangolin in present. Similar decreasing trends of pangolin populations were recorded by previous researchers (Kaspal, 2008; Bhandari, 2013). However, Gurung (1996) reported population of this species in the Nagarjun forest was increasing.

Most of the respondents were well known about the hunting of pangolin is illegal but also the hunting activities is not stopped. Majority of the locals responded that the species has been hunted time to time. The reason behind hunting the species is the scale and meat of pangolin for medicinal, trade (scale) and meat consumption purpose. The parts of pangolin i.e. scales and abdomen were recorded at local's house for medicinal purpose of disease like Jaundice. Suwal (2011) reported pangolins were directly consumed for meat, medicines and trades.

Illegal hunting was recorded as a major threats along with habitat degradation and the forest fire for the decline in population of pangolin in the study area. Others factors such as unplanned road construction, deforestation, grazing and encroachment were some reason for their habitat degradation. In the national level, habitat loss and poaching are the main threats for Chinese pangolin (Jnawali et al., 2011; Suwal, 2011). Grazing of domestic livestock's within the habitat area and human encroachment by unscientific cultivation, intentional forest fires and mining of stone caused the lost and degradation of habitat of pangolins which are the main threats for Chinese pangolin (Gurung, 1996). Forest fire was identified as one of the serious threats (Basnet et al., 2016) and incidences of forest fire are likely to increase due to climate change impacts leading to extended dry spells. Rampant development of rural roads has posed additional threats across their range (Basnet et al., 2016). Further this species is threatened by over exploitation, habitat loss and low breeding rate (Wu & Ma, 2007).

As the declining process is in alarming rate, most of the locals agree with the concept of protecting the mammal. According to the survey of 1993 conducted in Nagarjun Forest in Kathmandu, Nepal, determined that pangolin population residing the forest was healthy than that of the other areas where dramatically

declining process was in alarming rate, due to easy access to hunting areas and loss of habitat. In addition, it was observed that conflict between armed wildlife and forestry guards and local hunters was increased, seeking to utilize the resource (Gurung, 1996).

Pangolins were taken as the sign of bad luck in the study area, due to which if a pangolin comes into sight of people it was killed because it is thought that if it is left off it will create harm to their family. The Conservation status of Pangolins in the study area was found to be worst. This observation shows similar with the study by Suwal (2011) which states that pangolins are taken as sign of bad luck and moreover for profit purpose, they are killed and the conservation status of the mammal is worse. Similarly, Kaspal et al. (2016) observed a superstitious belief among local people that sighting of a pangolin brings bad luck and in such cases occasional killings are also reported. Dhakal (2016) observed that Chinese pangolin had negative impression in the villagers, scales were used for ornamental purpose and locals believed that pangolins drove evil spirits away, also the conservation status was bad with hunting and meat consumption at very high scale. CITES (2000) and Duckworth et al. (2008) discussed that poaching and habitat destruction as important factor for the decline of pangolin population.

Conclusion

Mahabharat and Chure community forests provide the prime habitats for the Chinese Pangolins in Sindhuli district. Burrows are the most prominent indirect signs for pangolins in the study area. Within the total block transects that covered 60 ha area in both of the study areas, 206 burrows with 91 active and 115 inactive burrows were observed in Mahabharat community forest while, 142 burrows with 57 active and 85 inactive were observed in Chure community forest. Clumped distribution pattern of burrows of Chinese Pangolin were observed in both study sites. The burrow density was found to be 3.4 burrows/ha and 2.3 burrows/ha in Mahabharat community forest and Chure community forest respectively. Results show that the significant factors responsible for the distribution of burrows in Mahabharat community forest are soil colour and texture, distance to water source and number of ant/termite mounds. However, elevation, aspect, soil colour and soil texture are also observed as the significant factors responsible for the distribution of burrows in Chure community forest. The density of burrows was found to be significant to the availability of food source in both community forest. Human intervention, poaching, habitat destruction (rampant development of rural roads), natural disasters (landslide and fire) were observed as the threats to pangolin at the sites. Similarly, through schedule survey, hunting, habitat destruction and forest fire are observed to be the major threats to pangolin. Illegal hunting by local people was mostly done for meat and medicinal purpose. Due to the lack of records at the DFO, the actual trade scenario of pangolin at the area is unknown. Population trend was found to be decreasing within last five years. People were well known that hunting is illegal but they were not aware that pangolin could be beneficial for us. Negative social belief on Chinese

pangolin as a sign of bad luck or cause harm to them and their family if the pangolin is encountered and left alive. Thus, the conservation status of Chinese pangolin at the study sites is deteriorating and there are no initiatives.

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