The Rufford Small Grants Foundation
Final Report

Congratulations on the completion of your project that was supported by The Rufford Small Grants Foundation.

We ask all grant recipients to complete a Final Report Form that helps us to gauge the success of our grant giving. We understand that projects often do not follow the predicted course but knowledge of your experiences is valuable to us and others who may be undertaking similar work. Please be as honest as you can in answering the questions – remember that negative experiences are just as valuable as positive ones if they help others to learn from them.

Please complete the form in English and be as clear and concise as you can. We will ask for further information if required. If you have any other materials produced by the project, particularly a few relevant photographs, please send these to us separately.

Please submit your final report to jane@rufford.org.

Thank you for your help.

Josh Cole, Grants Director

Grant Recipient Details	
Your name	Himani Nautiyal
Project title	Ecology and Conservation Status of the Virtually Unknown Central Himalayan Langur in the Kedarnath Wildlife Sanctuary, Northern India
RSG reference	16805-1
Reporting period	December 2015 to January 2016
Amount of grant	4900 £
Your email address	himani.nautiyal08@gmail.com
Date of this report	22/02/2016

1. Please indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Assess the habitat utilisation, foraging patterns and time-activity budgets of three troops of Central Himalayan langurs at three different altitudes in the Sanctuary.		X		Please refer to comment 1
Evaluate the differences in feeding behaviour and activity patterns with change in altitude, habitat type at these locations.		X		Please refer to comment 2
Assess the human-nonhuman primate interface with an emphasis on estimating the nature and extent of crop raiding by the species and the circumstances under which agricultural and horticultural crops are lost.			X	Please refer to comment 1

Comment 1:

Time spent on major activities

Lower altitude Village troop (1500-2000m) - The greatest proportion of time was spent by resting in this altitude (38.63%), followed by feeding (33.25%). Time spent on moving was less (11.68%) than resting and feeding. This troop used to spend a good amount of time on social activities (all grooming and playing, 11.95 %), with other activities like soil licking and self-scratching being very low compared to these major activities.

Middle altitude troop (2000-2500m) - At this altitude, the greatest proportion of time was spent on feeding (48.71%) followed by resting (32.49%) and moving. Time spent on social activities and other activities were low.

Higher altitude troop (2500-3000m) - The greatest proportion of time was spent by resting (39.08%) and feeding (30.81%) followed by moving (19.66%). Time spent on social activities (3.06%) was low compared to other activities (7.33%). (Refer: Figure. 1)

Diet

Combined, the three study troops were observed to feed on 82 species (67 genera and 43 families). The lower altitude Village troop (1500 m-2000 m) spent more time feeding on young leaves of *Prunus cerasoides* (26.69%), followed by unripe fruits of

Quercus leucotrichophora (20.85%) and young leaves of *Triticum spp* (6.50 %). The middle altitude troop spent more time feeding on young leaves of *Tetrastigma sp* (37.60%) followed by flush leaves of *Carpinus viminea* (23.71%) and ripe fruits of *Daphniphyllum himalayense* (6.36%). The higher altitude troop spent more time feeding flush, mature leaves and unripe fruit of *Aesculus indica* (23.84%) followed by unripe fruits of *Quercus semecarpifolia* (13.62%) and young leaves of *Quercus floribunda* (12.84%). There is only one shrub species eaten (*Berberis aristata)* and present between 1500 m-3000 m. It was observed to be consumed by all three troops. It is interesting to note that feeding on insects (caddis fly larva) was only observed in the higher altitude troop (Table.1).

Comment: 2

Changes in activity with altitude

The three study troops showed / demonstrated statistically significant differences in the amount of time allocated to Feeding (K-W-χ^2 =16.767, $p < 0.001$, df = 2). The middle altitude troop spent more time Feeding (48.71%) than did the higher altitude troop (30.81%) and the lower altitude village troop (33.25%). Similarly, it was recorded that Village troop (38.63%) and the higher altitude troop (39.08%) spent more time by resting, compared to the middle altitude troop (32.49%) (K-W-χ^2 =39.529, $p < 0.001$, df = 2). Time spent in Moving and Other activities (soil licking and scratching) was similar across the three troops. Time spent in / on social activities (allogrooming and playing) decreased with increasing altitude (village troop: 11.95%; middle altitude troop: 5.12%; higher altitude troop: 3.06%). The difference was statistically significantly (K-W-χ^2 =20.857, $p < 0.001$, df = 2). (Figure.1)

One of the possible reasons for this decrease in time devoted to social activities with increasing altitude could be predation risk differences between the three troops. The level of vigilance has been shown to be high during allogrooming in some primates to avoid predation (Cords, 1995). Most of the home range of the lower altitude village troop comes under human habitation and agricultural fields. The greater presence and activity of people around the village may reduce the presence of predators. With greater predation risks, allogrooming should decrease. The higher altitude troop spent less time on social activities, perhaps due to higher predation risk from leopards. Plant species richness is lower in high altitude forests above 2400 m (Gairola et al, 2011), meaning that tree cover is less dense compared to lower altitudes. This may make langurs easier to be spotted by leopards, maybe compelling them to be more vigilant at higher altitudes where they are more vulnerable. Time spent Resting was greater in the higher altitude troop compared to other two troops because of less time they spent grooming. Resting periods usually occur after Feeding, which are long, and troop members spend that time grooming and playing, however this was not the case with the higher altitude troop, whose individuals spent more time resting, not grooming, and scanning the horizon, perhaps looking out for predators.

Time spent on Feeding most likely differed because of differences in habitat quality and food availability during the particular season of this study. Time spent on Feeding was quit similar between the Village troop and higher altitude troop, but interestingly time spent Feeding was greatest in the middle altitude troop. These

differences were difficult to interpret, but it might be because of the differences in the diversity of food species the habitats of the three troops during the different time periods that observations were made. Observations on the middle altitude troop were made during a different season than those of village troop and higher altitude troop. Time spent Moving was almost similar for all three troops (10%-20%). It was not a major activity of the Central Himalayan langur. They spent more time on resting because they consume mainly leaves. Leaf eating specialists need longer resting periods to allow for microbial digestion to break down the cellulose in plant cell walls (Oates & Davies, 1994; Nadler et. al, 2003). A high percentage of time spent resting has also been observed in many other species of langurs, including the: Himalayan grey langur (*Semnopithecus ajax,* Sayers & Norconk, 2008) and Francois' langur (*Trachypithecus francoisi*, Qihai Zhou et. al, 2007).

Phonological change and dietary selection

In general, young leaves were highly consumed (43.71% of total diet) by village troop, while mature leaves were highly (45.38%) consumed by the middle altitude troop. Both troops were feeding on leaves more than any other plant parts (e.g. flower, fruits). On the other hand, the higher altitude troop spent more time feeding on unripe fruits (32.65%). This difference is possibly due to the different observation periods of these sites. The village troop was mainly observed in winter when fruits are not abundant so they fed more on leaves. The higher altitude troop was observed during the monsoon period when *Quercus semecarpifolia,* the dominant species of this altitude has abundant fruits in the forest. However, if we combined the percent of time spent feeding on all stages of leaves (flush, young and mature: 43.37%), then the time spent Feeding on leaves was higher than that spend Feeding on fruits. Overall, leaves were the main food part most highly consumed by all three troops. (Figure.2)

Time spent feeding on particular plant species, and the food items eaten were selected by their phonological stages. It is most likely being influenced by the extent to which the langurs' nutritional requirements could be fulfilled (Freeland & Janzen 1974; Milton 1980). Consumption of leaves, 70%-80% of the diet, probably satisfied their nutritional requirements of these langurs (see Krishnamani, 1994; Struhsaker, 1975). Difference in plant parts consumed shows that langurs are optimal foragers and can feed on multiple plant parts based on their availability and nutritional value.

Abundance and diet selection

In the village troop, there were no significant correlations between consumption and abundance of flush leaves, young leaves and mature leaves. This shows that the abundance of flush leaves, young leaves and mature leaves did not influence their selection as food. Unripe and ripe fruit were both statistically significantly positively correlated with abundance ($r=0.738$, $p<0.000$; $r=0.802$, $p<0.000$). The amount of time spent Feeding on flowers correlated positively with the abundance of flowers ($r= 0.843$, $p<0.000$). The middle altitude troop had positive correlations between consumption and abundance ($r= 0.598$, $p<0.000$) for flush leaves only. No statistically significant positive correlations were detected for young leaves and mature leaves. This shows that the abundance of young leaves and mature leaves did not influence the selection of either stage available. Unripe and ripe fruit consumption was statistically positively correlated with abundance ($r=0.759$, $p<0.000$; $r=0.996$, $p<0.000$).

Flower consumption was significantly positively correlated with their abundance ($r=0.660$, $p<0.000$). For the higher altitude troop, flowers and ripe fruits were not observed to be consumed because the study was done in the monsoon period when flower and mature fruit abundance is low, especially for those tree species consumed by langurs. Abundance of unripe fruits was significantly positively correlated with the percent of time spent Feeding on unripe fruits ($r= 0.395$, $p<0.00$). This shows that, overall they selected unripe fruits because they were abundant. No significant correlation was detected for flush, young and mature leaves. (Table.2)

Food resource abundance in a semi-evergreen forest changes with changing phenophases of the trees. This seasonal variation in phenology determines the presence of young leaves, mature leaves, fruits and flowers in a forest. Generally the period of resource abundance, or the flowering and fruiting season, is related to the onset of the monsoon. Winters are considered to be the lean periods when young leaves are scarce in the forest (Adhikari & Shrestha, 2011). In a recent review, Koenig & Borries (2001) noted a positive correlation between consumption and abundance of young leaves, flowers, and fruit in the feeding ecology of lowland grey langur populations, and suggested that they "feed on everything that is available except mature leaves." My study also showed a positively significant correlation between consumption and abundance for flush leaves, unripe fruits, ripe fruits and flowers. Central Himalayan langurs broaden the feeding repertoire of grey langurs by inhabiting a marginal environment so that mature leaves are ingested whenever they are available. The ability to subsist, at least seasonally, on non-preferred foods is likely one reason for the expansive geographical and ecological range of grey langurs, including decidedly marginal habitats such as the Himalayas. *Semnopithecus entellus* (Brandon-Jones, 2004) foraging behaviour has been the subject of at least ten long-term studies from a minimum of five sites (Sri Lanka: Hladik, 1977, Dahwar: Yoshiba, 1957, Nepal Himalays: Curten, 1975, Kanha: Newton, 1992, Jodhpur: Srivastava, 1998). Data from these studies substantiates their reputation as generalist feeders. While these studies represent a wide range of habitats from Sri Lanka to the Himalayas, the overall contribution of primary food types differs surprisingly little /negligible; leaf parts range from 45 to 60% of the diet.

Species preference index

The village troop spent the most time Feeding on *Prunus cerasoides* (PC, 26.69%), and the Vanderploeg and Scavia Relativized Electivity Index (*Ei**) indicated that it was the most preferred species, while Feeding on *Quercus leucotrichophora* (QL, 20.35%) was also high; it was not a preferred species. Likewise, AL-*Alnus nepalensis,* CS1- *Citrus sp1*, CT- *Cinnamomum tamala*, UN- Unknown, GO- Grewia optiva, CS2- *Citrus sp2*, CA- *Celtis australis*, PP- Pyrus pashia, RA- *Rhododendron arboretum,* FV- *Ficus virens* were commonly found species and were consumed by langurs, but they were not preferable species.

The middle altitude troop spent the most time feeding on *Carpinus viminea* (CV,23.71%) and UK2 (5.88%). According to the Vanderploeg and Scavia Relativized Electivity Index (*Ei**) these two species were most preferred species. On the other hand, *Daphniphyllum himalayense* (DH, 6.69%), whose total Feeding time was more than UK2, were not preferred species. The most frequently found species NP- *Neolitsea pallens,* AN-*Alnus nepalensis*, JR- *Juglans regia,* MD- *Machilus duthiei,* UK1- Unknown1, QL- *Quercus leucotrichophora*, QG- *Quercus glauca* which are also

consumed by langurs were not preferable species in this altitude. The higher altitude troop spent the most time Feeding on *Aesculus indica* (AI, 23.84%), Quercus floribunda (12.84%, QF), Sorbus cuspidate (SC, 5.34%), and Satanvaesia nussia (SN, 2.09%). According to the Vanderploeg and Scavia Relativized Electivity Index (*Ei**) they were most preferred species, while *Quercus semecarpifolia* (13.62%, QS) was also consumed frequently but was not a preferable species. Most frequently found species like *Acer acuminatum* (AA), *Acer caesium* (AC), UNK, *Rododendron arboretum* (RA), *Swida oblonga* (SO) are consumed by langurs but were not preferable species at this altitude. (Refer: Figure.3)

Comment: 3

I conducted a survey of 6 villages (Khala, Mandal, Gondy, Kunkuli, Sanso, and Siroli) covering the whole valley (Refer: Figure. 4). These results were characterised under the following categories.

Agricultural activity and livestock

The agricultural fields of these villages could be divided into two different landscapes types; flat open fields along the valley floor nearby the river and, terraced fields up on the hillsides with fodder tree crops planted in between the individual fields (Refer: Figure. 4). The main crops produced in Mandal valley, like elsewhere in the region, were finger millet (*Paspalum scrobiculatum,* 'Koda' in Garwhali), barnyard millet (*Echinochloa frumentacea,* 'Jhangora' in Garwhali), wheat, and rice. The harvesting season for the two millet species coincide in August. Wheat was harvested in June and rice in October. All of these crops are used only for home consumption, as the Himalayan region is unsuitable for economic crop production because of limitations of available space. Although available land for agriculture was roughly equal between the flat open fields (24.1 ha) and the terraced fields (28.6 ha), there were differences in average household crop yield and number of livestock according to their geophysical location within the valley. Crop yield tended to be higher down in the well-irrigated flat open fields compared to the steep terrace fields. Inversely, the number of livestock was higher in the terraced fields (Table.3). All households had bullock for ploughing the fields and cows for milk. Goats and sheep were kept for home consumption. Only a few households had mules for carrying home construction materials up to villages on the hillsides, and for the seasonal influx of religious tourists going to Anusuya (6 km trek) and Rudranth (26 km trek) temples high up in the mountains.

Langur crop consumption

Overall, 78% of the respondents reported that langurs entered their agricultural fields and consumed ripened crops during harvest times. Among these householders, the largest proportion reported damage to finger millet (35%), followed by wheat (21%), barnyard millet (13%), and lastly rice (9%). When asked about the most frequently used method for keeping langurs out of the agricultural fields, the use of dogs to chase them away accounted for 62% of the responses followed by 19% who used firecrackers and 17% who ran out and chased after them, themselves. Interestingly, 1% of the respondents said they did nothing, because the Forest Department provides compensation for damage to their crops. (Refer figure5)

Table.4 shows the breakdown of reported crop damage by langurs according to village and type of the agricultural fields. There was a statistically significant difference between villages reporting whether langurs were damaging their agricultural crops or not ($\chi 2$= 39.25, p= 2.13-7, df=5). The villages reporting the greatest degree of crop damage by langurs was Sanso, Siroli and Kunkuli (three villages with agricultural fields on the terraced slopes). The difference between terraced slope agricultural fields and flat open fields with regards to the degree of households reporting damage by langurs was statistically significant ($\chi 2$= 27.04, p= 2e-7, df=1).

Peoples' perception of langurs

When asked how they perceived langurs, respondents often gave more than one response. The contradiction in views, often held by the same respondent, reveals the complexity of the situation. Table.5 shows the ranking of responses into four major categories. While 98.14% of respondents reported that langurs were agricultural pests, everyone agreed that langurs were a part of nature, just like themselves, with 39.54% responding that humans should take care of them. Interestingly, 61.87% also considered them to be evil. This view is influenced by Garwhali mythical beliefs which say that evil spirits are black faced and have large canines. Some people believe that lone male langurs encountered in the forest are evil creature's attempting to enter the person and take over their bodies. It is believed that this can only be cured by having a traditional holy man perform an exorcism. When ranked as the primary perception of the people about langurs, 62.33% of all respondents reported them as being agricultural pests. This was also reflected in the WRI (Table.5).

There was a significant difference in reporting langur as pests among the six villages ($\chi 2$=39.25, p = 2.1e-7, df = 5). Significantly more households with flat open fields responded that langurs were not a problem (10.92%), compared with those having terrace fields (2.08%). This difference was statistically significant ($\chi 2$=27.041, p= 2e-7, df=1), again suggesting that fields on the steep terraced slopes were more susceptible to crop raiding.

Reasons for langur crop raiding

When asked if the langurs had always raided their agricultural crops, 76.28% of the respondents said no. When asked what they thought was the primary reason for langur crop raiding, 46.52% of the respondents attributed this to the increase of livestock fodder trees planted in their agricultural field (Table. 6). The increase appears to be due largely to the natural recruitment of new seedlings, which are not cut down, though some people do plant new trees as well. The planting of fodder tree species in the agricultural fields is most prevalent along terraced slopes, utilizing the available space between terraces.

The second most common primary perception (32.10%) was that langurs were increasingly coming to the agricultural fields because the surrounding forest cover was decreasing (Table.6). While nobody reported this as their primary perception, 76.28% of the respondents said that the number of langurs was actually increasing because the Forest Department did not permit the killing of langurs, suggesting that if permitted they would shot langurs to protect their crops. Other miscellaneous reasons given by respondents but not analysed in Table.6 include climate change,

planting of mulberry trees around the flat open field, and feeding competition with translocated rhesus macaques in the forests.

Views on wildlife conservation and ways to decrease langur crop raiding

Given the threats to the livelihood of local people from wildlife damage to their crops, when asked what should be done with crop raiding pests, 30.24% of the respondents stated that they should be shot. When asked whether or not wildlife should be conserved however, 74.24% said yes. When asked what measures should be taken to reduce crop damage from langurs, the most frequently received response (37.21%) was to put up fences around the agricultural fields, followed by having the Forestry Department hire guards to protect the fields (18.60%). Roughly equal numbers of respondents said that langurs should either be eradicated or translocated from the area (Table.7). Because langurs fall under the jurisdiction of the Forestry Department, the local villagers see it as the department's responsibility to control the langurs and other wildlife.

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled (if relevant).

Working in the Himalayas itself was challenging because of the steep terrain and harsh climatic conditions. I have studied the three troops in different altitudes (1500 m-3000 m). Following the troops between 2000 m-3000m was difficult compared to the 1500m troop. Due heavy snowfall and blocked roads at the 3000 m level, I was not able to study three troops in the same season. To deal with this challenge, I have studied this particular high latitude troop in different seasons. Another problem that I faced during study of the village langur troop was the local people, especially kids, threw stones at the langurs every time they saw them, not only when they were in the agricultural land, but also when they were in the nearby forest area. This particular troop has agricultural areas taking up a big part of their territory. They were forced to live in the village area because they cannot enter other troop's territory. When they spent time in the nearby forest area of their own territory, people chased them from their as well. I tackled with this problem by giving a talk about the social life of langurs especially to primary school kids in the village where langur conflict is high and also showed them langurs in the field so that they could get a chance to observe langur life. This reduced the problem of throwing stones at the langurs when they are not in the agricultural area.

3. Briefly describe the three most important outcomes of your project.

1- Langurs troops in different altitudes showed differences in the time spent on major activities. This was largely because of the habitat, food abundance and differences in potential predator pressure. Altitudinal changes coincide with changes in the flora and fauna composition, which plays an important role in determining the amount of time left over after feeding and resting to spend on social activities; by these highly social animals in the Himalayas. Social activities are an important part of the activity of social animals, but with changes in time required for feeding and resting to aid digestion after feeding, the amount of time left for social activities was negatively affected.

2- Outcome of the tree species preference results can serve as a management tool to increase the base of existing food resources by planting those important food

species in the sanctuary. Conserving *Carpinus viminea* trees, the most important winter food resource is important, since it was found in small numbers in the middle altitude zone between 2000 m-2500 m. This study also showed that langurs living in the anthropogenic farmland (1500 m-2000 m) preferred *Prunus cerasoides*. Wider planting of this species at the periphery of the village may reduce crop raiding by the langurs in winter. According to the Forest Department, they are facing natural regeneration problems for *Quercus leucotrichophora* in the higher altitude zone. Langur feeds more on the unripe fruits of this species during the monsoon season. Encouraging more planting of the most preferable langur food species *Aesculus indica,* will help reduce the feeding pressure on *Quercus leucotrichophora* and lead to successful regeneration in the higher altitude zone.

3- Outcomes of the village survey shows that villagers are facing crop raiding by langurs and they are destroying all the major crops grown in all seasons. The present study was conducted across the whole valley and recorded significant differences in how people reported the problems with langurs. The highest level of reported crop damage occurred in the terraced fields. The lowest level of complaints came from villages in the flat open fields. Major differences in these two landscape types are the presence and absence of tree species used as fodder crops. Planting of more fodder crops in the forest near by the village may reduce the pressure on agricultural fields. Because langurs are more attract to the terraced fields, which have fodder crops planted on the edges of the fields.

4. Briefly describe the involvement of local communities and how they have benefitted from the project (if relevant).

For this one-year study I hired a local field guide and one lady for management of the camp. Both are very poor and they were able to get some source of income through this project. I did a small awareness camp in the Siroli primary school. In the awareness program, I showed the children langur photographs in story form, and told them about their life style and how they are similar to humans in so many ways. I also held a painting competition in which they had to draw their favourite animal. After that, I took them into field during their off days to show them langurs in wild. The area, especially my field site, attracts a lot of bird watchers from across the country, so participation in these kind of activities, beginning from childhood can help train children and provide them with knowledge of the flora and fauna that they can use in the future to be a good local nature guide. This is a very good income source. (Refer figure6)

5. Are there any plans to continue this work?

I want to continue this work for the long term as short period of time is not enough to get sufficient information about the ecology of this least studied primate species in the Himalayas. It is also very important to engage with the community to educate them about their natural resources so they can explore its use in a sustainable way. Having spent one year in this site, I came to know the problems faced by local people and the animals sharing the territory with them in the Himalayas. I want to learn ways to deal and mitigate these problems benefitting both stakeholders. Realizing this long term objective requires more detailed study and long-term commitment.

6. How do you plan to share the results of your work with others?

I am working on a small documentary of this one-year project, which can be uploaded online on social platforms like (YouTube, Facebook etc.) making it easily available to everyone. I am also writing research articles, one that describes the peoples' perception of wildlife and crop damage caused by them across the whole valley, especially damage caused by langurs. The second paper is about the ecology and behaviour of langurs in the Himalayas. I am going to submit these to reputed international journals for publication. I have already published a popular article in Sanctuary Asia Magazine (one of the leading magazine in India for wildlife and conservation). The link to the online article is available on my page at Rufford website. This study is also part of my master's thesis, which is submitted to the A.V.C Collage library and is accessible for all students. I have also presented my work at the Primate Research Institute of Kyoto University, located in Aichi Japan, and at the National Institute of Advanced studies, a part of the Indian Institute of Science Bangalore, India. I am also going to give a talk about my project results in the "5th International Symposium on Primatology and Wildlife Science" (March 3- March 6, 2016) to be held in Inuyama City, Japan. I also have plans to present other study results in other international conferences later on in the year.

7. Timescale: Over what period was the RSG used? How does this compare to the anticipated or actual length of the project?

The project was started two months before the actual planned time in order to record the winter diet of langurs. It started in December 2015 and ended in January 2016.

8. Budget: Please provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used.

Item	Budgeted Amount	Actual Amount	Difference	Comments
Return air travel from headquarters to the field	250	300	50	Due to changes ticket fare according to time
Local travel (vehicle hire, bus and train fares)	550	550	30	
Accommodation for two persons (Investigator and Field Assistant): GBP 130 per month per person for eight months.	2080	2080	0	
Salary: One Field Assistant and one Field Guide: GBP 70 per month per person for eight months.	1120	1120	0	
Field gear (torches, batteries and camping equipment) and clothing	300	300	0	
Binoculars	140	140	0	
GPS	130	130	0	

Consumables and Stationery- includes costs for publication of information leaflets in the field and reports Contingency	200	200	0	
	Total	4950		

Exchange rate- 1GBP=100 Indian Rupees

9. Looking ahead, what do you feel are the important next steps?

The most important next steps are to get more ecological information about this species and also to work with the community. I feel, it's important now to know about the ecology of the langurs which are living in the very extreme high altitude meadows that are sharing food resources with the local community livestock. From my first year project I learned that, I cannot get detailed information of the species ecology from higher altitude areas if I have a short period of time, so I want to study these langurs in the higher meadows for a longer period of time. The villagers of the same village where I did my one-year project take their cattle to the higher meadows and spend 7-8 months with them. I think that looking at the interactions of langurs and livestock will be helpful to understand the overall scenario of people and primate interaction in the broad context of the area. As per my prior visit to those meadows, langurs were observed to share food resources with livestock because of few trees near the timberline. A major part of diet that they get from the meadow's plants are seasonal and grazed on by the livestock too, it will be important to look at the possible parasite transmission from livestock to langurs, and compare this with the langurs which do not share food patches with livestock.

10. Did you use the RSGF logo in any materials produced in relation to this project? Did the RSGF receive any publicity during the course of your work?

I have used the logo in my presentation given at Kyoto University's Primate Research Institute and at the National Institute of Advanced Studies, Bangalore, India. I will use in my talks at other international conferences in the future dealing with this one-year project.

11. Any other comments?

We would like to thank Rufford Small Grant for making this study possible. As less explored areas needs more work, we hope that the foundation will continue is support in the near future.

Below:
Tables; Figure; References and Pictures

Table .1. Time spent feeding on plant part in relation to the different altitude zones between 1500-3000m. **FL**-flush leaves, **YL**- young leaves, **ML**- mature leaves, **UF**-unripe fruits, **RF**- ripe fruits, **FLW**-flowers, **H**-herb, **S**-shrub, **T**-tree, **C**-climber, **M**-moss.

S.N	Species	Family	Type	Part	% of diet		
					1500-2000	2000-2500	2500-3000
1	*Acer acuminatum*	Aceraceae	T	FL,YL	-	-	2.57
2	*Acer caesium*	Aceraceae	T	FL,ML	-	-	2.55
3	*Adhatoda zeylanica*	Acanthaceae	S	ML,RT	3.02	0.32	-
4	*Aesculus indica*	Hippocastanaceae	T	ML,YL,UF	-	-	**23.84**
5	*Agrimonia pilosa*	Rosaceae	H	ML	-	-	0.50
6	*Arundinella bengalensis*	Poaceae	G	RT	-	0.67	-
7	*Amanita chepangiana*	Amanitaceae	M	Cap	-	-	0.62
8	*Amanita rubrovolvata*	Amanitaceae	M	Cap	-	-	0.44
9	*Asplenium sp*	Aspleniaceae	H	ML	-	-	0.53
10	*Alnus nepalensis*	Belulaceae	T	FL	0.83	0.07	-
11	*Berberis aristata*	Berberidaceae	S	ML	4.91	0.04	1.47
12	*Bupleurum falcatum*	Apiaceae	H	FLW,ML	-	-	1.69
13	*Brassica spp.*	Brassicaceae	H	FL	3.61	-	-
14	*Carpinus viminea*	Belulaceae	T	FL	-	23.71	-
15	*Caryopteris odorate*	Verbinaceae	H	YL	0.13	-	-
16	*Celtis australis*	Ulmaceae	T	YL	1.25	-	-
17	*Centella asiatica*	Apiaceae	H	ML	-	-	0.69
18	*Citrus spp. 1*	Rutaceae	T	YL	0.10	-	-
19	*Citrus spp. 2*	Rutaceae	T	RF	5.68	-	-
20	*Cinnamomum tamala*	Lauraceae	T	YL	0.19	-	-
21	*Cirsium wallichii*	Compositae	H	Stamp	-	-	2.20
22	*Cupressus torulosa*	Cupressaceae	T	RF	-	0.12	-
23	*Daphniphyllum himalayense*	Daphniphyllaceae	T	RF	-	6.36	-
24	*Debregeasia solicifolia*	Urticaseae	T	FL	-	0.30	-
25	*Erigeron multiradiatus*	Asteraceae		FLW	-	-	3.48
26	*Flimalrandia tetrasperma*	Rubiaceae	S	ML	-	1.30	-
27	*Festuca gigantea*	Poaceae	G	ML	-	-	2.22
28	*Fragaria nubicola*	Fragaria nubicola	H	RF	-	-	3.56
29	*Ficus sarmentosa*	Moraceae	T	YL	0.38	-	-
30	*Ficus virens*	Moraceae	T	FL	0.21	0.09	-
31	*Grewia optiva*	Malvaceae	T	ML	2.23	-	-
32	*Hedera nepalensis*	Araliaceae	C	UF	1.63	2.20	-
33	*Ipomoea nil*	Convolvulaceae	CL	ML	-	-	0.27
34	*Impatiens edgeworthii*	Balsaminaceae	H	FLW,ML	-	-	1.66
35	*Jasminum dispermum*	Nyctaginaceae	C	YL	-	0.08	-
36	*Jasminum officinale*	Oleaceae	C	ML	0.53	0.30	-
37	*Juglans regia*	Juglandaceae	T	FL	-	0.12	-
38	*Lyonia ovalifolia*	Ericaceae	T	FL	-	1.38	-
39	*Machilus duthiei*	Lauraceae	T	ML	-	1.25	-

40	*Myrica esculenta*	Myricasea	C	ML	0.81	-	-
41	*Neolitsea pallens*	Lauraceae	T	YL	-	0.43	-
42	*Prinsepia utihs*	Rosaceae	S	YL	-	0.65	-
43	*Pyrecantha crenatata*	Rosaceae	T	YL	0.05	0.26	-
44	*Pyrus pashia*	Rosaceae	T	YL, FLW,FL	5.17	0.01	-
45	*Persicaria polystachya*	Polygonaceae	H	FLW	-	-	0.54
46	*Potentliia fulgens*	Rosaceae	H	YL	-	-	1.05
47	*Perse odoratissima*	Lauraceae	T	YL	0.13	1.33	-
48	*Quercus leucotrichophora*	Fagaceae	T	FL,RF,UF	20.85	1.85	-
49	*Quercus floribunda*	Fagaceae	T	YL	-	-	12.84
50	*Quercus semecarpifolia*	Fagaceae	T	UF	-	-	13.62
51	*Quercus glauca*	Fagaceae	T	FL	-	0.03	-
52	*Rosa brunoni*	Rosaceae	S	FL,YL	0.18	0.30	-
53	*Rubus paniculatus*	Rosaceae	C	FL	0.04	4.49	-
54	*Rubus ellipticus*	Rosaceae	S	FL,ML	1.42	1.75	-
55	*Reinwardtia indica*	Linaceae	H	YL	1.99	-	-
56	*Rhododendron arboreum*	Ericaceae	T	FLW,FL	0.58	2.27	0.18
57	*Rosa sericea*	Rosaceae	CL	L	-	-	1.63
58	*Russula lepida*	Russulaceae	M	Cap	-	-	0.37
59	*Satanvaesia nussia*	Rosaceae	T	YL	-	-	2.09
60	*Sorbus cuspidata*	Rosaceae	T	FL,YL	-	-	5.34
61	*Swertia chirayita*	Gentianaceae	H	FL	-	-	0.29
62	*Swida oblonga*	Cornaceae	T	YL	-	-	2.51
63	*Shuteria involucrata*	Fabaceae	CL	YL	-	-	0.54
64	*Stephami spp.*	Menispermaceae	C	ML	4.29	1.98	-
65	*Tetrastigma spp.*	Vitaceae	C	YL	-	37.60	-
66	*Ttifolium repens*	Fabaceae	H	YL, ML	-	0.77	0.81
67	*Prunus Avium*	Rosaceae	T	YL	0.13	-	-
68	*Prunus cerasoides*	Rosaceae	T	YL	**26.69**	-	-
69	*Sinarundinaria falcata*	Poaceae	G	YL	0.44	-	-
70	*Triticum spp.*	Poaceae	G	YL	6.50	-	-
71	*Thamnocalamus apathiflora*	Poaceae	B	Stamp	-	-	4.96
72	*Toona cilata*	Meliaceae	T	FL	0.36	-	-
73	*Woodfordia fruticosa*	Lythraceae	S	FL, YL	2.17	-	-
74	*zanthoxylum arnatum*	Rutaceae	S	YL	1.20	-	-
75	UK1	-	T	ML	-	1.67	-
76	UK2	-	T	RF	-	5.88	-
77	UK3	-	H	RT	1.51	-	-
78	UK4	-	H	-	-	-	0.66
79	Paper	-	O	-	0.05	0.25	-
80	Moss	-	M	RT	0.58	0.39	-
81	Caddisfly larva	-	IN	-	-	-	3.67
82	Fern	-	P	-	-	-	0.35

Table. 2. Spearman Rank correlation for weighted abundance and consumption of plant parts for the three langur troops by altitude. **FL**-flush leaves, **YL-** young leaves, **ML**- mature leaves, **UF**- unripe fruits, **R**F- ripe fruits, **FLO**- flowers and *= significant at the 0.05% level.

Parts eaten		**FL**	**YL**	**ML**	**RF**	**UF**	**FLW**
1500 m -2000 m	**r**	0.062	0.220	0.129	0.738	0.802	0.843
	p	0.387	0.151	0.274	**0.000***	**0.000***	**0.000***
	n	24	24	24	24	24	24
2000 m-2500 m	**r**	0.598	-0.062	0.319	0.996	0.759	0.660
	p	**0.002***	0.774	0.064	**0.000***	**0.000***	**0.000***
	n	24	24	24	24	24	24
2500 m-3000 m	**r**	0.137	0.080	0.135	0.395	-	-
	p	0.467	0.673	0.478	**0.031***	-	-
	n	30	30	30	30	-	-

Table.3. Annual crop yield, total land area and number of livestock across six villages in the Mandal Valley study area.

Village	**Average annual households crop yield (Kg)**				**Agri-fields (ha)**	**No. of Livestock**
	Rice	**Wheat**	**Millet**	**Ragi**		
Flat open fields						
Gondy	78.8	75.5	82.1	82.1	5.0	98
Khala	169.5	159.9	103.8	105.7	10.8	152
Mandal	134.2	157.7	78.5	77.6	8.3	92
Terraced fields with trees						
Kunkuli	54.8	41.7	69.6	78.3	6.1	105
Siroli	64.6	64.6	59.4	60.3	19.0	241
Sanso	68.1	68.1	57.5	57.5	3.5	134

Table.4. Specific crop damage from langurs as reported by village and the geospatial location of their field within Mandal valley.

	Flat open fields			**Terraced fields with trees**		
Villages	**Gond**	**Khala**	**Mandal**	**Kunkuli**	**Siroli**	**Sanso**
(Number of households)	(n=33)	(n=53)	(n=33)	(n=23)	(n=57)	(n=16)
No crop damage % (N= 215)	48.48	66.03	33.33	21.73	21.05	0
Damage listed by crop % (N=						
ragi	35.71	43.90	27.94	42.31	54.88	81.82
wheat	21.43	12.20	27.94	26.92	36.59	18.18
millet	23.81	31.71	22.06	19.23	4.88	0.00
rice	19.05	12.20	22.06	11.54	3.66	0.00

Table.5. Respondents attitude towards langurs as being the primary problem, ranked by the perceived relative importance of these problems and the overall Weighted Rank Index (WRI) value for each problem (N= 215 respondents).

Attitudes of People	**% of respondents reporting as being a problem**	**% of respondents reporting as being the primary problem**	**WRI**
Agricultural pest	98.14	62.33	0.790
Part of nature as I am	100	17.24	0.509
Representation of evil	61.87	19.07	0.480
As an animal that humans should take care of	39.54	1.40	0.309

Table.6. Perceived reasons for langurs being attracted to agricultural fields, ranked by the perceived relative importance of these problems and the overall Weighted Rank Index (WRI) value for each problem (N= 215 respondents).

Perception of People	**% of respondents reporting as being a problem**	**% of respondents reporting as being the primary problem**	**WRI**
Agro-forestry crops have increased in the village	99.07	46.52	0.724
Forest Department does not permit killing of langurs	76.28	0.00	0.341
Forest cover has decreased, so langurs come into fields	95.35	32.10	0.341
I don't know why	15.82	10.24	0.334

Table.7. Proposed crop field protective measures given by Mandal Valley villagers.

Proposed measures to protect crops	**% of respondents**
Fencing around the agricultural fields	37.21
Field guards hired by forest department	18.60
Increases forest cover	6.98
Eradicate langurs	5.12
Translocate langurs	4.65
Hired local people to guard fields	1.40
Capture and cage langurs	0.93
No idea	25.12

Figure.1. Comparison of the activity budgets of three troops of langurs in altitude zones between 1500 m and 3000 m. 1500 m-2000 m (n=592), 2000 m-2500 m (n=586), 2500 m-3000 m (n=508).

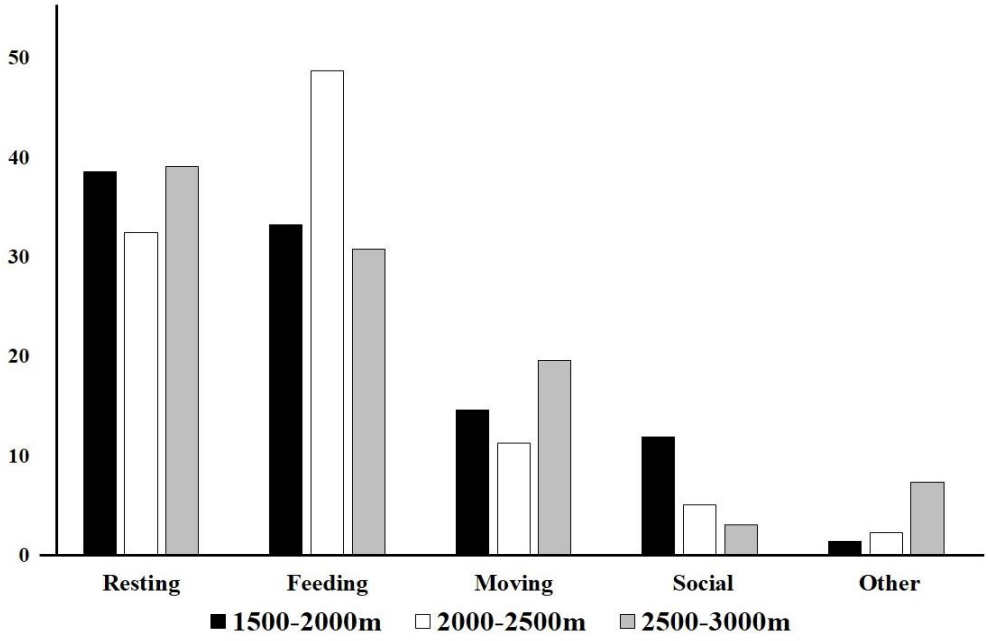


Figure.2.

Comparison of plant parts consumed by three troops of langurs in three altitude zones between 1500 m and 3000 m. 1500 m -2000 m (n=592), 2000 m-2500 m (n=586), 2500 m-3000 m (n=508).

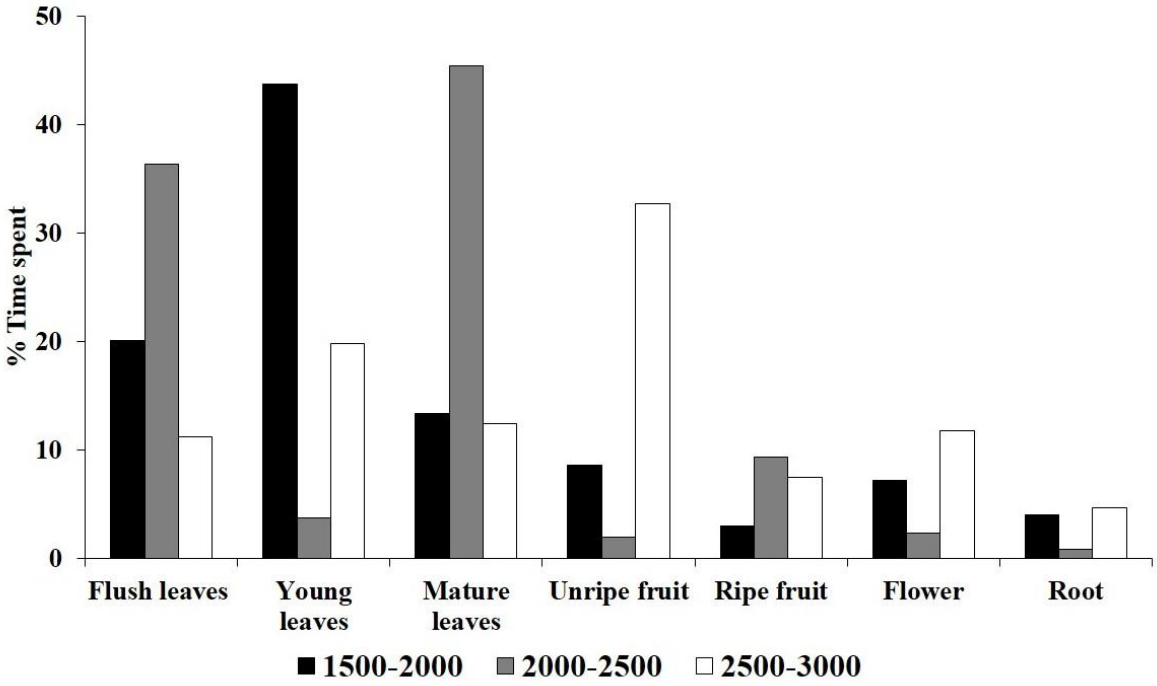
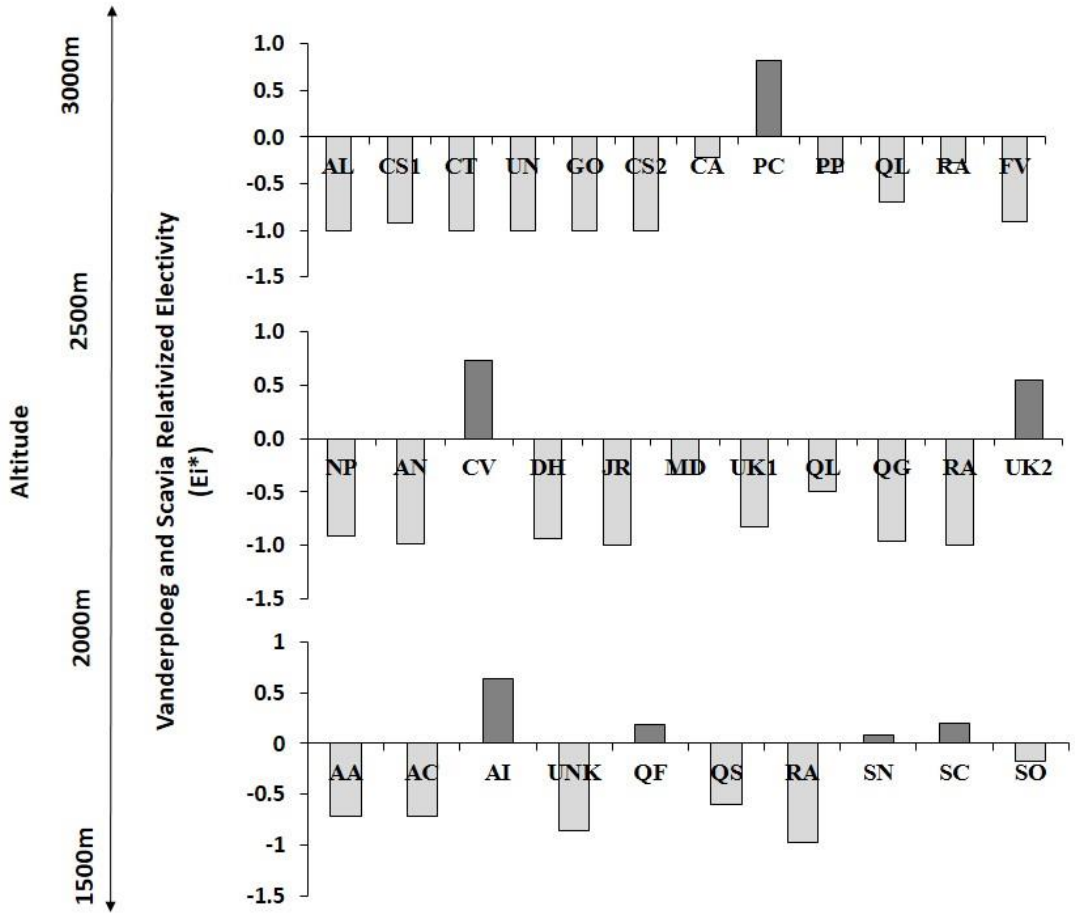


Figure.3. Electivity indices of plant species using Vanderploeg and Scavia Relativized Electivity (*Ei**) for three troops of langurs altitude between 1500 m-3000 m.



References

Adhikaree, A and Shrestha, T. K. 2011. Food item selection of Hanuman Langur (*Presbytes entellus*) in different session in Char- Koshe junge of Eastern Terai, Nepal. *Nepalese journal of Bioscience*, 1:96-103

Cords, M. 1995. Predator vigilance costs of allogrooming in wild blue monkeys. *Behaviour* 132(7–8): 559–569.

Curtin, R. A. 1975. The socioecology of the common langur, *Presbytis entellus*, in the Nepal Himalaya. Ph.D. thesis, University of California at Berkeley.

Gairola, S.Sharma, C.M. Ghildiyal, SK and S, Suyal. 2011. Tree species composition and diversity along an altitudinal gradient in moist tropical montane valley slopes of the Garhwal Himalaya, India. *Forest Science and Technology* 7: 91-102.

Hladik, C. 1977. *A comparative study of the feeding strategies of two sympatric species of leaf monkeys: Presbytis senex* and *Presbytis entellus*. Clutton-Brock TH, editor.In: Primate ecology. New York: Academic Press, pp. 324–353.

Krishnamani, R. 1994. Diet composition of the bonnet macaque (Macaca radiata) in a tropical dry evergreen forest of southern India. *Tropical Biodiversity* 2: 285-302.

Newton, P. 1992. Feeding and ranging patterns of forest hanuman langurs (*Presbytis entellus*). *Int J Primatol* 13:245-85.

Nadler, T. Momberg, F, Nguyen Xuan Dang and Lormee, N. 2003. *Vietnam Primate Conservation Status Review* 2002: Part 2: Leaf Monkeys. Fauna & Flora International-Vietnam Program and Frankfurt Zoological Society, Hanoi

Oates, J. F, Davies, A. G and Delson, E. 1994. *The diversity of living colobines*. In A. G. Davies & J. F. Oates (Eds.), Colobine monkeys: Their ecology, behaviour and evolution (pp. 45–73). Cambridge: Cambridge University Press.

Qihai Zhou. Q, Fuwen Wei, Chengming Huang, Ming Li, Ren B and Luo B. 2007. Seasonal Variation in the Activity Patterns and Time Budgets of *Trachypithecus francoisi* in the Nongang Nature Reserve, China. **Int. J. Primatol**. 28, 657-671.

Struhsaker, T.T. 1975. The red colobus monkey. University of Chicago Press, Chicago

Sayers. K, Norconk, M.A. 2008. Himalayan Semnopithecus entellus at Langtang. National Park, Nepal: Diet, Activity Patterns, and Resources. *Int J Primaltol*. 29:509–530.

Srivastava, A. 1989. *Feeding ecology and behaviour of Hanuman langur*, *Presbytis entellus*. Ph.D. thesis, University of Jodhpur, India.

Yoshiba, K. 1967. An ecological study of Hanuman langurs, *Presbytis entellus*. Primates 8:127-54.

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