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## Journal of Threatened Taxa

Building evidence for conservation globally

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ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

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#### DISTRIBUTION AND POPULATION OF HIMALAYAN MARMOT *MARMOTA HIMALAYANA* (HODGSON, 1841) (MAMMALIA: RODENTIA: SCIURIDAE) IN LEH-LADAKH, JAMMU & KASHMIR, INDIA

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26 November 2017 | Vol. 9 | No. 11 | Pp. 10886–10891  
10.11609/jott.3336.9.11.10886-10891



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ISSN 0974-7907 (Online)  
ISSN 0974-7893 (Print)

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 November 2017 | 9(11): 10886–10891

## DISTRIBUTION AND POPULATION OF HIMALAYAN MARMOT *MARMOTA HIMALAYANA* (HODGSON, 1841) (MAMMALIA: RODENTIA: SCIURIDAE) IN LEH-LADAKH, JAMMU & KASHMIR, INDIA

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**Abstract:** The Himalayan Marmot *Marmota himalayana* is one of the largest rodents of cold desert habitats, found mainly between 3,500–5,200 m above the timberline. It is regarded as an ecosystem engineer and constitutes part of the diet of some globally endangered carnivores in the Trans-Himalayan region. Being one of the least studied rodents, a survey was carried out in different habitats of Leh District along the altitude gradient to assess the status and distribution of Himalayan Marmots. A total of 110 individuals of Himalayan Marmots were sighted in the surveyed stretches of Leh District with a maximum mean count of encounter of 2.71 in the Tangtse-Chushul sector. The grasslands were the most preferred habitat (41.67% activity observed), whereas, cultivation area being frequently disturbed for agricultural operation were least preferred by the marmot. Most of the population of marmot was found between 4,000–4,500 m altitude and the steep slopes (42.05%) where loose soil was available for excavation of burrows.

**Keywords:** Altitude, Alpine, distribution, Himalayan Marmot, Leh, threatened species.

Marmots (genus *Marmota*) are large, generally social ground squirrels (Sciuridae: Marmotini) that evolved and radiated in North America in the Miocene and Pliocene era and spread into Eurasia in the late Pliocene or early Pleistocene. They are Holarctic rodents with marked adaptations for living in cold climates (Armitage

2000, 2013). The habitats occupied by marmots range from small, widely scattered alpine meadows to the widespread steppe environment. Due to human interventions and climate change issues marmots are facing threats to their survival across their distribution range. Globally all the recognized 15 species of marmots are restricted to the northern hemisphere (Steppan et al. 2011), of which six species occur in North America and nine in Eurasia (Armitage 2013). Of these only two species occur in India, viz., the Long-tailed Marmot or Golden Marmot *Marmota caudata* (Least Concern; Cassola 2017) and the Himalayan Marmot *Marmota himalayana* (Least Concern; Shrestha 2016). The former is a common resident of central and western Ladakh, between 3,500m and 5,000m, occasionally also seen in the lower valley slopes. The latter inhabits a restricted zone ranging from 3,500m to the timberline/cold desert (5,200m) in the Himalayan ranges in Nepal, parts of Tibet (China), Pakistan and parts of India (Ladakh, Kashmir, Garhwal and Sikkim) (Alfred 2006). The Himalayan Marmot *Marmota himalayana* is one of the largest species of marmots in the world, stoutly built with short legs and a small stubby tail. Its head-body length varies

**DOI:** <http://doi.org/10.11609/jott.3336.9.11.10886-10891> | **ZooBank:** urn:lsid:zoobank.org:pub:250CFA5A-17C5-4CD7-901A-998C13AA9A45

**Editor:** Spartaco Gippoliti, Società Italiana per la Storia della Fauna 'G. Altobello', Roma, Italy.

**Date of publication:** 26 November 2017 (online & print)

**Manuscript details:** Ms # 3336 | Received 10 February 2017 | Final received 01 November 2017 | Finally accepted 04 November 2017

**Citation:** Chaudhary, V., R.S. Tripathi, Surjeet Singh & M.S. Raghuvanshi (2017). Distribution and population of Himalayan Marmot *Marmota himalayana* (Hodgson, 1841) (Mammalia: Rodentia: Sciuridae) in Leh-Ladakh, Jammu & Kashmir, India. *Journal of Threatened Taxa* 9(11): 10886–10891; <http://doi.org/10.11609/jott.3336.9.11.10886-10891>

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**Funding:** Indian Council of Agricultural Research, India.

**Competing interests:** The authors declare no competing interests.

**Acknowledgements:** The authors are thankful to Director, ICAR- Central Arid Zone Research Institute, Jodhpur for providing facilities and support in conducting the study. We are also thankful to the technical staff, Sh. Ramesh Chand Meena, Central Arid Zone Research Institute, Jodhpur and S/Sh, Heera Lal Kudi, Lakhani Singh, Jigmat Stanzin, and Ms, Landol Stanzin, Regional Research Station Leh, Central Arid Zone Research Institute for their support during the course of study.

between 47.5–67 cm and tail length between 12.5–15 cm with an average body weight between 4–9.2 kg (Thorington Jr. et al. 2012).

The Himalayan Marmot is regarded as an ecosystem engineer because of the effect of its burrowing on soil fertility and plant diversity in the mountain ecosystems (Brown & Heske 1990; Bagchi et al. 2006). Himalayan Marmots are also considered as pests in parts of the Asian highlands, and in some areas are frequently subject to lethal control (Jing et al. 1991; Zhong et al. 1991; Bagchi et al. 2006). Marmots are also harvested for fur, meat, and illegal trade, and may in some countries be over-harvested. In affected areas, harvesting for illegal trade and lethal control are considered the major causes of decline of marmot populations (Bagchi et al. 2006; Murdoch et al. 2009). Except for some scattered reports of Pfister (2004), Tak & Sharma (2003), Alfred et al. (2006) and Ahmed et al. (2016) on distribution and abundance, the Himalayan Marmot is the one of the least studied rodent species in the Palearctic region.

Considering this, a survey was carried out from June to September in 2014, 2015 and 2016 in different habitats

along the altitudinal gradient to assess the status and distribution of Himalayan Marmots *M. himalayana* in Leh District. The current information is expected to help future researches on this lesser known species.

## MATERIALS AND METHODS

### (a) Study area

The targeted area for study was Leh District, which includes three tehsils, namely, Leh, Khalsi and Nubra. It is situated in the Ladakh region of Jammu & Kashmir in Indian Trans-Himalaya between 32°15'–36°N & 75°15'–80°15'E with an altitude ranging from 2,900–5,900 m (Fig. 1).

The vegetation of Ladakh is mainly 'dry alpine scrub' with no forest cover. The vegetation is desert-like, consisting of low shrubs and herbs, however, some trees like poplar, *Populus* spp. and willow, *Salix* spp. grow along river-valleys. The rangelands of the region are also characterised by low graminoid biomass (Mishra 2001). Vegetation changes gradually from alpine meadows (*Kobresia*, *Cares*, *Potentilla*, *Nepeta*, etc.) to steppe vegetation (*Caragana*, *Artemisia*, *Stachys*, *Ephedra*,

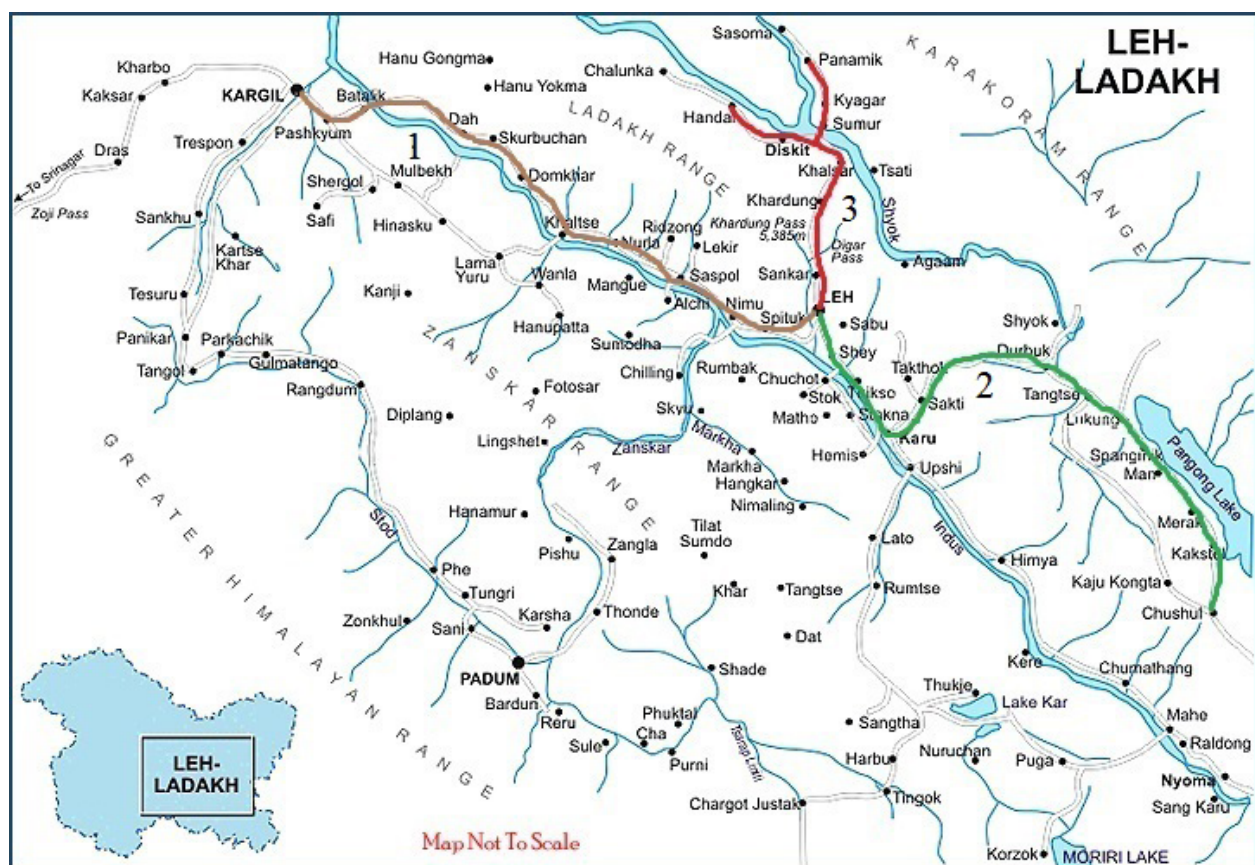


Figure 1. Route followed in different sector surveyed

*Stipa*, etc.) with shrub land (*Hippophae*, *Myricaria*, *Salix*) along river courses (Raj & Sharma 2013). Cultivation is mainly in valleys where water sources such as glacial streams are available. Barley, wheat and some special varieties of pea and other vegetables are the major crops cultivated in the region.

Leh-Ladakh support a unique ecosystem with several endemic large mammal species such as the Wild ass (khyang) *Equus kiang*, Tibetan Ibex (skyyin) *Capra sibirica*, Snow Leopard (shyan) *Panthera uncia*, Wolf (shanku) *Canis lupus chanco* and Fox (watse) *Vulpes vulpes*. Domestic animals include Yak *Bos mutus*, Double Humped Camel *Camelus bactrianus*, Pashmina Goat *Capra aegagrus hircus*, Sheep and horse (Namgail 2009).

### (b) Survey

The survey was carried out along three major routes in such a way that each of the three tehsils of Leh was well represented. The major routes considered for survey were Kargil-Matayen-Khalsi-Leh (Route 1); Leh-Karu-Chang la-Tangtse-Lukung-Chusul (Route 2) and Leh-Khardungla-Hunder & Panamik (Route 3) across the altitude, beginning from Khaltse at an altitude 2,987m to as high as Khardung la at an altitude of 5,342m. Besides, Matayen village of Kargil at an altitude of 3,247m was also included in the study due to the presence of marmots near crop fields. Following Alfred et al. (2006) the survey was conducted by road transect method on a vehicle driven at a slow speed (15–20 km/h) to record the Himalayan Marmot sightings. During the survey, marmots were seen in the barren land near the steeps, along the green grassy undulating riverbeds very close to water and rocky areas near the base of hills since their distribution was not continuous. So, it was decided that wherever such potential habitats were seen during the survey along the valleys, roughly half an hour was spent in the vehicle quietly to count the marmots, seen either basking or feeding in their potential habitats along valleys. On foot inspection of such patches was also done to ascertain the presence of live burrows. Due to hostile weather conditions, on high altitude and serpentine marshy riverbeds it was very difficult to standardize length and width of transect strips. After assessing four to five good marmot inhabited patches, a small strip of 100m length and 20m width was selected for live marmot burrows count to record height and width of the entrance. Behavioral observations and actual counts of the individuals out of the burrows were made with the aid of Zeiss Dialyt 10x40 B field binoculars. Two to three observers validated counts in each patch during bright day light hours and the time

spent in each patch was kept constant throughout the study area. Photographs were also taken using 300mm zoom lens of Nikkor fitted to a Nikkon camera.

The following nine sectors/segments under the three major routes mentioned earlier were surveyed (Fig. 1)

1. Kargil-Matayen-Khalsi-Leh
2. Leh-Durbuk-Tangtse
3. Tangtse-Lukung
4. Tangtse-Chushul
5. Leh-North Pullu
6. Leh-North Pullu-Khalsar
7. Khalsar-Hunder
8. Khalsar-Panamik
9. Leh-South Pullu-Khardung-Hunder

### RESULTS AND DISCUSSION

A survey of a stretch of approximately 750km of the three tehsils of Leh District provided the opportunity to observe the activity of marmots in all their potential habitats across the altitude. A total of 110 individuals of Himalayan Marmots were sighted in the surveyed stretches of Leh District with a maximum mean count of encounter of 2.71 in Tangtse-Chushul sector (Images 1–5). Likewise marmot population was least (1.5) in Leh-Kargil sector of the survey stretch (Table 1). Similar observations were also reported by Alfred et al. (2006). The presence of maximum population of marmots in Tangtse-Chushul sector may be attributed to the sparse and low human population in the region. Ahmed et al. (2016) also reported avoidance of human activities by marmots in Kargil areas. Altitude wise maximum population of marmots was observed at an elevation above 4,000m. Ecological studies also suggest that Himalayan Marmots most often occur between timberline and snowline (Armitage 2000). In the stretches, Kargil-Leh, Tangtse-Lukung-Chusul, Khalsar-Panamik and Leh-Hunder the population of marmots were more in hilly areas (65.12%) followed by valleys (24.42%) and plateaus (10.4%). The population at different topography levels was significantly different ( $X^2=41.58, df=2, p<0.01$ ). It may be due to the habitat preference of marmot as they inhabit crevices/dens in the foothills. Similar observations were recorded by Ahmed et al. (2016) for Long-tailed Marmot in their study area of Rangdum Valley (Kargil). Higher population of marmots in these stretches having vast grassland may be attributed to adequate food and shelter availability due to more grass cover. Alfred et al. (2006) also found that the population of marmots was less in areas with less grass cover.

Lower slopes in the surveyed stretches were occupied

**Table 1. Sightings of Himalayan Marmot in different habitat types in Leh-Ladakh, Jammu & Kashmir, India**

Date	Surveyed stretch	Marmots observed	Mean±SE	Number of sightings	Distance travelled (km)
19.vii.2014	Kargil-Leh	06	1.50±0.29	4	210
26.vii.2014	Leh-Tangtse	10	2.00±0.32	7	125
27.vii.2016	Tangtse-Lukung	23	2.56±0.34	9	50
27.vii.2016	Tangtse-Chushul	19	2.71±0.29	7	47
27.ix.2014	Leh-North Pullu	7	2.33±0.33	3	55
22.viii.2015	Leh-North Pullu-Khalsar	10	2.50±0.65	4	40
23.viii.2015	Khalsar-Hunder	8	2.67±0.33	3	30
23.viii.2015	Khalsar-Panamik	12	2.00±0.32	6	40
02.vii.2016	Leh-South Pullu-Khardung-Hunder	15	2.14±0.30	8	159

more by Marmots (66.29%) than middle (26.97%) and upper (6.74%) slopes. This difference in occurrence of Marmots in different slopes was significant ( $X^2=87.75$ ,  $df=3$ ,  $p<0.01$ ). More vegetation cover in the vicinity and ease of access may be the reason for more occupancy of lower slopes. Rodrigue et al. (1992) also observed that slope, sun exposure and plant cover significantly affect the habitat choice by *Marmota marmot* in the French Alps. Our findings of significantly more population of marmots at lower slopes are in line with the findings of Ahmed et al. (2016) for Long-tailed Marmots. In the present survey, the maximum number of marmots was observed in areas of steep slope (42.05%) as in these areas soil was loose and made up of moraine making it is easy for marmots to excavate burrows. In the area of moderate and flat slope the population of marmots was almost at par, whereas it was less in the areas of very steep slopes (Table 2). The results are congruent with Ahmed et al. (2016), who also observed a similar pattern of distribution of Long-tailed Marmots in Rangdum Valley. The higher sighting of marmots on slopes also corroborates with the findings of Panseri & Frigerio (1996) and Qureshi et al. (2015). Marmots in general prefer steep to moderate slopes, as such slopes provide good drainage (Armitage 2013). In all the nine surveyed stretches (Table 1) damage in cultivated fields due to marmots was observed in Matayen Village in Kargil-Leh stretches only. We observed four marmots near cultivated fields, where their burrows were located mainly in foothills. Excavated burrows in the field were almost negligible. In other stretches, no activity of

**Image 1. Himalayan Marmot in rocky habitat****Image 2. Himalayan Marmot near steep slope****Image 3. Den of Himalayan Marmot**

marmots was observed near cultivated fields. Maximum activity of marmots was observed in grassland (41.67%) followed by scrubland (29.76%), the reason probably being the availability of food and ease in excavation of burrows. A significant variation in the activity of marmots was observed in the different habitats ( $X^2=42.27$ ,  $df=4$ ,  $p<0.01$ ), which was in conformity with the reports of

**Table 2. Abundance of Himalayan Marmot recorded at various habitat variables in Leh-Ladakh, Jammu & Kashmir, India**

Variable	Category	Frequency of sighting	% of sighting	Total individuals encounter	P value X <sup>2</sup>
Topography	hilly	56	65.12	67	P<0.01
	plateau	9	10.47	13	
	valley	21	24.42	30	
Location	cliff	0	0.00	0	P<0.01
	lower slope	59	66.29	63	
	middle slope	24	26.97	37	
	upper slope	6	6.74	10	
Elevation (ft)	3,000–4,000	11	15.07	19	P<0.01
	4,000–4,500	41	56.16	56	
	<4500	21	28.77	35	
Slope	flat	16	18.18	27	P<0.01
	moderate	27	30.68	30	
	steep	37	42.05	43	
	very steep	8	9.09	10	
Habitat	scrubland	25	29.76	31	P<0.01
	grassland	35	41.67	44	
	riverine	9	10.71	16	
	rocky	11	13.10	15	
	cultivation	4	4.76	4	

**Image 4. Himalayan Marmot giving alarm****Image 5. Himalayan Marmot basking outside its burrow**

Ahmed et al. (2016).

The study reveals a fair abundance of Himalayan Marmots in Leh District, as their activities were observed in all the tehsils. Among the different sectors surveyed the maximum marmots were encountered in the Tangtse-Chusul sector. Himalayan Marmots most often occur between timber and snowline and in our study also the maximum number of marmots were observed at an elevation of above 4,000m. Steep slopes being the area of loose soil and moraine was preferred by the marmots due to ease in excavation of burrows. Grasslands were the most preferred habitat for the Himalayan Marmot (41.67% activity observed) due to availability of food and safe shelter with least disturbance. Cultivation areas being most disturbed were least preferred by Himalayan Marmots.

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ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

November 2017 | Vol. 9 | No. 11 | Pages: 10865–10984

Date of Publication: 26 November 2017 (Online & Print)

DOI: 10.11609/jott.2017.9.11.10865-10984

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