Distribution and diet of brown bears in the upper Mustang Region, Nepal

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Abstract: We investigated the distribution and diet of brown bears (*Ursus arctos*) in the Upper Mustang Region (UMR) of the Annapurna Conservation Area (ACA) in Nepal by interviewing local residents (n = 166) and collecting bear sign (n = 109). Residents reported that brown bears predominantly used the Dhalung and Chungjung pastures and the Damodar Kunda Valley of the UMR from May to November, as well as the unprotected area between this region and Shey–Phoksundo National Park. We conducted dietary analyses on 56 bear scats; bears were predominately carnivorous in the UMR. Plant matter comprised 8% of fecal volume in scats. Small mammal hair was the most commonly identified item (75%), with marmots (*Marmota himalayana*; 46%) being the largest contributor. In addition, hair from ungulates (14%) and livestock (10%) were identified in scats. Few bear depredations occurred between 2003–10 in the UMR.

Key words: Annapurna Conservation Area, bear incident, brown bear, diet, distribution, Nepal, Upper Mustang, *Ursus arctos*

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Brown bears (*Ursus arctos*) occur in small isolated populations in remote mountain regions of Eurasia and North America (Servheen 1990, Servheen et al. 1999). The Himalayan brown bear (*U. a. isabellinus*) and Tibetan brown bear (*U. a. pruinosus*) are thought to occur in very low densities in disconnected alpine regions (Galbreath et al. 2007) of the Greater and Trans-Himalayan regions of India (Sathyakumar 2006) and the Tibetan Autonomous Region of China (Jackson 1990, Schaller 1998, Harris 2008), respectively. Although Schaller (1998) reported that the Himalayan brown bear is distributed in northwestern Nepal, the subspecies that occurs in this region is currently unconfirmed.

Little is known about the ecology of brown bears in Nepal (Gurung 2004, Aryal et al. 2010). Brown bears have been sighted and their sign collected in the Upper (Chetri and Gurung 2004, Gurung 2004) and Lower (Schaller 1998) Mustang Regions of the Annapurna Conservation Area (ACA) and the Manasalu Conservation Area (Aryal et al. 2010). Brown bears are also thought to occur in northwestern Nepal and the western Dolpa region (Gurung 2004), which includes Shey–Phoksundo National Park and the unprotected region connecting the Park to the ACA (Aryal et al. 2010; Fig. 1).

We investigated the distribution and diet of brown bears in the Upper Mustang Region (UMR) of the ACA by interviewing area residents and collecting brown bear sign from the region. Results from this study will be used to develop a comprehensive brown bear conservation plan for Nepal.

Study area

The UMR (approximately 2,500 km^2) of the ACA (Fig. 1) is home to approximately 5,700 non-winter human residents in 7 Village Development Committees (hereinafter villages). The UMR is located in the Dhaulagiri–Annapurna mountain rain-shadow zone and is characterized as cold desert, desiccated by strong winds and high solar radiation. Most of the area remains under snow from November to March, and total annual precipitation is <200 mm, half of which is winter snow (Chetri and Gurung 2004, Annapurna Conservation Area Project [ACAP] 2010).

Agricultural production in the area is limited due to low rainfall and scarcity of ground water, lack of mechanised irrigation, and long periods of low temperatures. The majority of the land is uncultivated and barren, with only 1.7% of the area being

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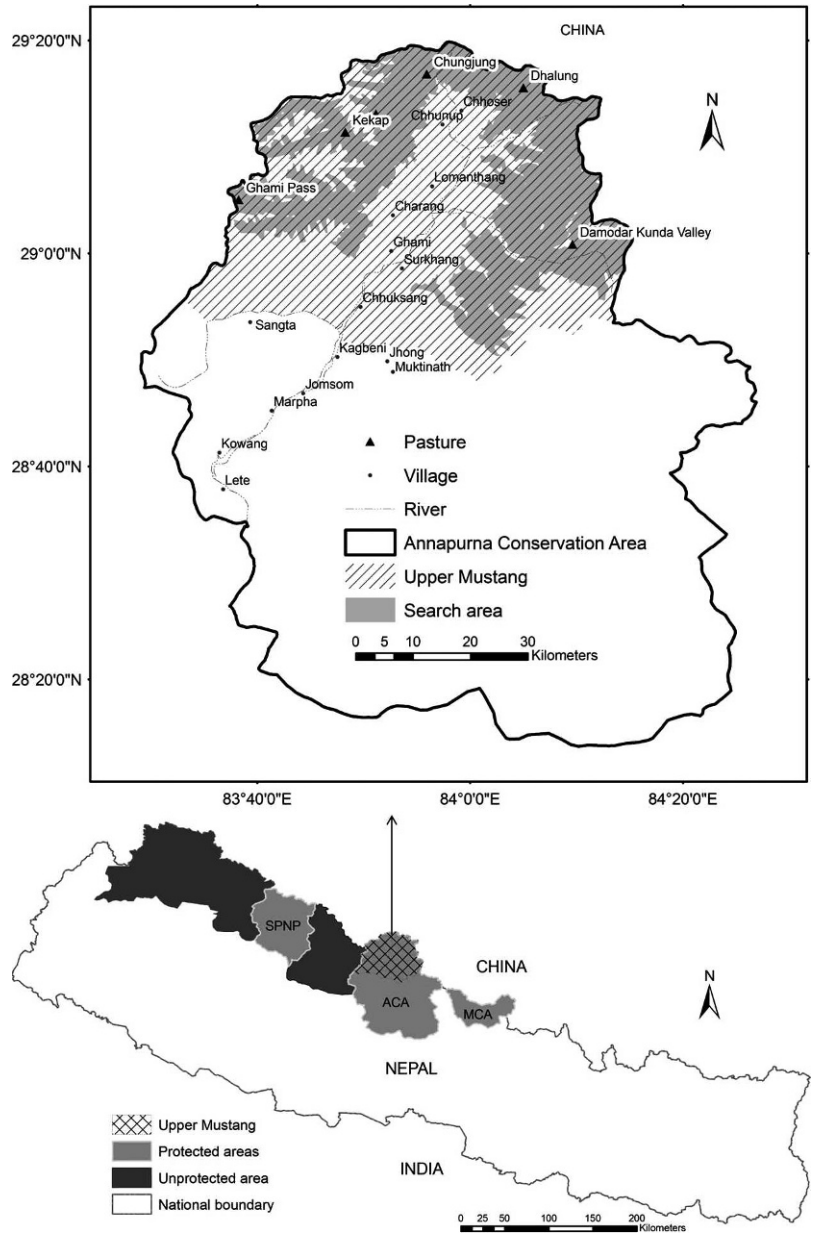

Fig. 1. The Upper Mustang Region of the Annapurna Conservation Area, Nepal. In addition to searching for sign in the search area (gray: from 3,800–6,000 m), we also searched for sign around each village and en route to each search area.

cultivatable (approximately 0.35 ha/person). Local production of food meets only 55% of subsistence needs, and only 8% of the local population are self-sufficient on their own agricultural products (Chetri and Gurung 2004, ACAP 2010).

Animal husbandry is the main source of income for area residents, and goats and sheep are regularly traded with China (Chetri 2008). In 2002, an average of 36,503 livestock were raised by residents, including cattle, yaks, dzos (cattle/yak hybrid), sheep, goats, horses, donkeys, and mules (Chetri 2008).

The rangelands of the UMR (Fig. 1) provide grazing opportunity for livestock and also support a biodiversity of native flora and fauna (Chetri 2008).

Table 1. Brown bear sign and sightings collected in the Upper Mustang Region, Nepal, 2009–11.

	Sampling period				
Bear sign	Oct–Nov 2009 (57 days)	Mar–Apr 2010 (20 days)	Jul–Oct 2010 (49 days)	Jun 2011 (26 days)	Total (152 days)
Scats	23	4	19	10	56
Digs	14	7	12	6	39
Tracks	4	0	0	5	9
Hairs	0	0	3	0	3
Bear sightings	2	0	0	0	2
Total	43	11	34	21	109

These high-altitude Tibetan grassland communities comprised a diversity of plants including *Caragana* spp., *Lonicera* spp., *Stipa* spp., *Carex* spp., *Kobresia* spp., and *Lagotis* spp. (Chetri and Gurung 2004) as well as predators including snow leopard (*Panthera uncia*), lynx (*Lynx lynx isabellinus*), brown bear, and grey wolf (*Canis lupus*) (Chetri and Gurung 2004, Chetri 2008). The prey species for these predators include argali (*Ovis ammon*), Tibetan gazelle (*Procapra picticaudata*), wild ass (*Equus kiang*), blue sheep (*Pseudois nayaur*), Himalayan marmot (*Marmota himalayana*), Royle's pika (*Ochotona roylei*), and Himalayan woolly hare (*Lepus oiostolus*).

Methods

Brown bear sign

We searched the UMR for brown bear sign during October–November 2009, March–April and July–October 2010, and June 2011 (Table 1). We conducted our search from 3,800 m to 6,000 m (Fig. 1). We identified areas to search in 2009 by interviewing residents ($n = 166$) in each of the 7 villages (Fig. 1). We searched areas where: (1) bears had been sighted by local residents; (2) bear depredations had occurred; or (3) bear sign had been observed. We also searched for sign around each village and during our travel to each site. In 2009, 6 field staff searched each area by walking 10–100 m apart along trails and riverbeds. In 2010 and 2011, we conducted more extensive searches of each area. In particular, we searched Ghami and Charang in March–April 2010, Damodar Kunda in July–October 2010, and Dhalung and Chhoser in June 2011. At each area, we collected bear scats and bear hair and documented bear tracks and excavated marmot burrows (digs, Fig. 2).

Diet analysis

We visually identified bear scats (Xu et al. 2006), as no other species in the study area produce feces similar to bears. We washed scats in hot water and separated hair, bones, and plants. We calculated the percent volume of plants and unidentified matter in our sample. We then identified prey species from each scat using microscopic methods similar to those described by Mukherjee et al. (1994) and followed by Aryal and Kreigenhofer (2009). We soaked hair in xylol for 24 hours. We thoroughly mixed the hairs and blindly selected a random cluster from each sample. We mounted these hairs on slides for identification (Aryal and Kreigenhofer 2009). We matched the medulla and cuticle structure for the first 17 hairs from each sample to reference material collected from dead animals in the region and from references provided by Bahuguna et al. (2010). We observed slides under a light microscope and photographed each sample (Aryal and Kreigenhofer 2009). We identified each hair to species and grouped species by dietary category: (1) small mammals, (2) ungulates, (3) livestock, or (4) birds. We calculated the percent frequency of occurrence (total hairs of a species or dietary category/total hairs) for each species in our sample and for each of the four dietary categories.

Bear depredations

We recorded brown bear depredations of livestock during interviews with residents and validated reports by interviewing their family members or other residents from the area. These cross-checks were necessary to avoid exaggeration of numbers of livestock killed. We also estimated monetary losses due to livestock depredations by interviewing local herders and determining the market value for livestock.

Results

Brown bear sign

Of 166 local residents, 109 reported an increase in brown bear presence in the UMR from 2009–11. Local residents ($n = 8$) reported bear sightings ($n = 2$)

Fig. 2. Excavated marmot burrows from the Dhalung area, Upper Mustang Region, Nepal, 2009. Photo on the left and upper right are images of the same excavated burrow.

in Dhalung pasture and Damodar Kunda Valley. Based on reports from 48 local residents (all from Ghami, Surkhang, and Sangta), we infer brown bear presence in the unprotected area between the UMR and Shey–Phoksundo National Park; most of these residents reported that bears were resident in this unprotected area throughout the year (Fig. 1). On 3 October 2009, we observed a bear (83°46′59.29″E, 29°12′1.86″N) between 1.5–2 km away, excavating a marmot burrow (Fig. 2) in the high pastures around Kekap. On 16 October 2009, we observed a different bear (83°39′12.57″E, 29°4′51.7″N) bedded down in grassland between Ghami Village and Ghami Pass.

We collected bear sign from all areas where residents reported that they had observed sign. In addition to our 2 bear sightings, we collected sign (n = 109; Table 1) at sites around Chhoser, Chhunup, Lomangthang, Ghami, and Surkhang (Fig. 1); however, no bear sign was observed <4 km from any village in the study area. We collected 2 hair samples at excavated marmot burrows in the Damodar Kunda Valley and 1 sample from a burrow in Dhalung (Fig. 2). We collected all sign from 4,300 m to 5,500 m (Fig. 3).

Dietary analysis

We collected scats (n = 56) from 4 regions of the UMR (Fig. 1): Chhoser/Chhunup (n = 14); Lomanthang (n = 3), Ghami (n = 16); and Surkhang (n = 23). We did not separate scats by season or by site because of low sample size. Instead, the diet data (Table 2) are a summary of the entire collection of scats. Plant matter and unidentified material (including unknown insect chitin exoskeleton from unidentified insects [n = 3], but not including bones), comprised 8% and <1% of fecal volume, respectively. Hair from small mammals was the most frequently identified prey category, followed by ungulates, livestock, and birds (Table 2). Marmots were was the most commonly identified prey species, followed by pika, woolly hare, blue sheep, yak, sheep, wild ass, argali, and goat (Table 2). Although residents never observed bears preying on ungulates in the area, a resident did report a bear scavenging on an argali in the Damodar Kunda Valley.

Brown bear depredations

From interviews, we documented only 6 livestock depredations occurring during May–November 2003–10: 1 yak in Panga (2003; also reported in Chetri 2008), 1 yak in Ghami (2009), 1 yak (2008) and 1 goat (2009) in Dhalung, and 1 yak and 1 sheep in Damodar Kunda (2010). These depredations resulted in an estimated financial loss of approximately 86,000 Nepalese Rupees (USD = $1,229): 4 yaks (80,000), 1 goat (3,000), and 1 sheep (3,000).

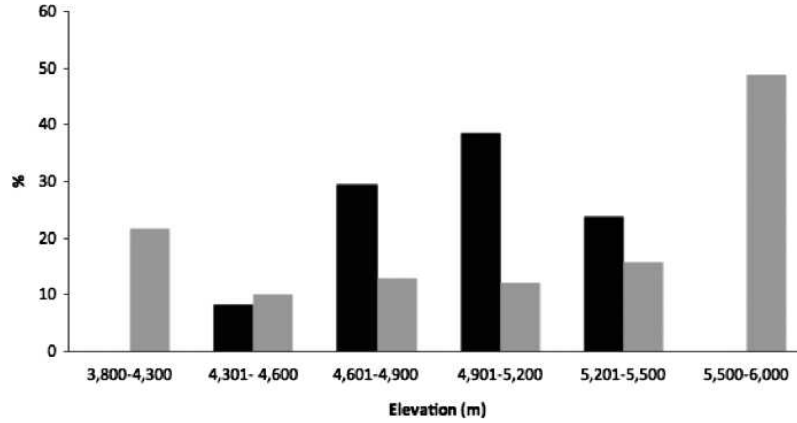

Fig. 3. Elevation of study area (gray bar) and sign (black bars) collected in the upper Mustang region, Annapurna Conservation Area, Nepal, 2009–11.

Discussion

Reports from local residents and a lack of bear sign near villages indicate that bears do not frequent villages and rarely feed on livestock in the UMR. Instead, residents reported that most of their losses were attributed to snow leopard predation in the mountains. However, we found that approximately 10% of hairs identified in scats were from livestock, suggesting that brown bears might feed on livestock more often than local residents reported. Similar to the Manasalu Conservation Area (Aryal et al. 2010), a continued increase in brown bear activity in the UMR could lead to increases in livestock depredations and other bear incidents (as defined in Hopkins et al. 2010).

Our dietary analyses suggest that brown bears are mainly carnivorous in the UMR because plants comprised only about 8% of the fecal material. Similar to Qinghai Province, China (Xu et al. 2006), brown bears primarily preyed on small mammals and likely scavenged on wild ungulates. Our results suggest that bears preferentially feed on marmots in Nepal (see also Aryal et al. 2010), whereas the preferred prey in China has been reported to be plateau pikas (*Ochotona curzoniae*; Smith and Foggin 1999, Xu et al. 2006, Worthy and Foggin 2008).

China has recently attempted to reduce grazing pressure by eradicating plateau pika from some areas (Miehe 1988, 1996). These programs may have had a negative effect on the reproduction and survival of brown bears in China (Smith and Foggin 1999, Xu et al. 2006). In addition to pika reductions, hunting and lethal control of marmots has increased to prevent the spread of bubonic plague on the Tibetan Plateau (Worthy and Foggin 2008).

We advocate future research efforts to confirm brown bear presence along the border of Nepal and China. We also recommend initiating regional brown bear research efforts that focus on estimating their occupancy and movements using both genetic hair–snare sampling and GPS data. In particular, it is important to conduct such research in Shey-Phoksundo National Park and the unprotected land

Table 2. Relative occurrence (%) of hairs in brown bear scats ($n = 56$) sampled in the Upper Mustang Region, Nepal, 2009–2011. We grouped feathers and identified hair from prey species using microscopic analysis.

Food items	Number of hair or feather samples	Frequency of occurrence (%)
Small mammals		
Himalayan marmot	441	46.3
Royle's pika	180	18.9
Himalayan woolly hare	90	9.4
Small mammal total	711	74.6
Ungulates		
Blue sheep	79	8.3
Wild ass	36	3.8
Argali	22	2.3
Ungulate total	137	14.4
Livestock		
Yak	44	4.6
Sheep	40	4.2
Goat	9	1.0
Livestock total	93	9.8
Birds	12	1.2
Total	953	

between this park and the ACA to determine if this land serves as a corridor between these protected areas.

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