Status assessment of wild felids with a special focus on clouded leopard and Asian golden cat in the Hugu-Kori forest, Annapurna Conservation Area, Nepal

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Zusammenfassung

Über Verbreitung und Ökologie von Kleinkatzen in den mittleren Höhenlagen des Himalaja in Nepal ist wenig bekannt. Sie spielen eine wichtige Rolle in den Waldökosystemen der Mittelgebirge und regulieren die Populationen von Säugetieren und Vögeln. Ökologische grundlegende Daten über ihre relative Anzahl, Habitatnutzung und Schutzstatus fehlen jedoch. Im Rahmen unseres Projekts haben wir beabsichtigt, den Status von Wildkatzen im Hugu-Kori-Waldgebiet innerhalb des Annapurna Naturschutzgebietes in Nepal mit einem besonderen Fokus auf Nebelparder und Asiatische Goldkatzen zu ermitteln.

Das Annapurna Naturschutzgebiet erstreckt sich über eine Höhenlage von 790–8090 Meter und ist mit einer Fläche von 7.629 Quadratkilometern das größte Schutzgebiet Nepals. Es schließt tropische, gemäßigte und alpine Klimazonen ein, in denen 22 verschiedene Waldtypen und 97 Säugetierarten vorkommen. In diesem Naturschutzgebiet erstrecken sich die Mittelgebirge über eine Höhenlage von 1001–3000 m und umfassen subtropische und gemäßigte Klimazonen. Unser Untersuchungsgebiet liegt in den östlichen Mittelgebirgen, südlich der Gipfel von *Annapurna II* und *Lamjung Himal*, am Oberlauf des Flusses *Madi*, der eine tiefe Schlucht zwischen den Gebirgszügen bildet. Das nächstgelegene Dorf *Sikles* befindet sich in den Hügeln westlich des Flusses. Von dort dauert der Marsch in das Untersuchungsgebiet einen bis zwei Tage.

Unsere Untersuchung ist die erste, die im Hugu-Kori-Waldgebiet mithilfe von Kamerafallen durchgeführt wurde. Vom 18. Januar bis zum 20. Februar haben wir 15 Kamerafallen entlang von Wildpfaden in insgesamt 59 Standorten angebracht, die in den Hügeln östlich des Flusses *Madi* konzentriert waren. In insgesamt 338 Kamerafallen-Nächten haben wir eine Aufnahme eines Nebelparders *Neofelis nebulosa*, 20 Bilder von Leoparden *Panthera pardus* und 32 Bilder von Bengalkatzen *Prionailurus bengalensis* erhalten. In 53 Kamerafallen-Nächten westlich des Flusses sind lediglich zwei Aufnahmen von Bengalkatzen entstanden, beide unterhalb von 1670 m Höhe im Südwesten des Untersuchungsgebietes. Die anderen 51 Aufnahmen von Katzen sind in 285 Kamerafallen-Nächten in den Hügeln östlich des Flusses entstanden.

Der **Nebelparder** wurde am 8. Februar um 19:11 Uhr auf einer Höhe von 2174 m 78 Minuten nach Sonnenuntergang fotografiert (Bild auf Seite 14). Die geringe Aufnahmerate bedeutet nicht unbedingt, dass die Katze im untersuchten Gebiet ausgesprochen selten ist, sondern dass sie sich selten in der Nähe von Wildpfaden aufhält, die von Leoparden, Bengalkatzen und deren Beutetieren frequentiert werden. Angesichts der von Hemmer (1968) dokumentierten Kletterkünste von Nebelpardern ist es wahrscheinlich, dass die Katze bevorzugt in höheren Etagen von Bäumen lebt, die unsere Kamerafallen nicht abgedeckt haben. Wir empfehlen daher ein Studiendesign, das die Beobachtung von Baumstämmen und des Kronendachs mithilfe von Kamerafallen einschließt.

Von 20 Bildern, die **Leoparden** zeigen, sind 17 in Höhenlagen von 2128–2494 m entstanden und drei zwischen 2504 m und 2575 m Höhe. Ein männlicher Leopard wurde am Nachmittag in der Zeit von 14:34–14:51 Uhr fotografiert. Die anderen Bilder entstanden zwischen Sonnenuntergang und 46 Minuten nach Sonnenaufgang. Anhand von unterschiedlichen Zeichnungen an Kopf und vorderen Flanken konnten wir zwei männliche Individuen identifizieren (Bilder auf Seite 14).

Vier der 32 Aufnahmen von **Bengalkatzen** sind in der Höhelage von 2568–2860 m und 26 Bilder in 2019–2494 m Höhe entstanden. Die Bengalkatzen wurden zwischen 57 Minuten vor Sonnenuntergang bis 52 Minuten nach Sonnenaufgang fotografiert und bestätigen die nachtaktive Lebensgewohnheit der gefleckten Kleinkatze.

Unsere Ergebnisse legen den Schluss nahe, dass die Katzen sich vornehmlich in bewaldeten Gebieten in Höhenlagen über 2000 m aufhalten, da unsere Aufnahmerate dort höher war als unterhalb.

Ob die **Asiatische Goldkatze** *Pardofelis temminckii* im Studiengebiet vorkommt, ist nicht sicher. Wir haben auf über 2400 m Höhe Spuren einer Katze mittlerer Größe gefunden, die wir mit Spuren von Asiatischen Goldkatzen und Nebelpardern verglichen haben, die im Zoo Wuppertal leben. Die Spuren lassen sich jedoch nicht eindeutig einer der beiden Arten

zuordnen. In weiter östlich gelegenen Naturschutzgebieten des Himalaja wurden Asiatische Goldkatzen zumeist in Gebieten dokumentiert, die über 2500 m Höhe liegen. Da unsere Untersuchung sich auf 42 Kamerafallen-Nächte in der Höhe von 2510–2860 m beschränkte, schließen wir die Möglichkeit nicht aus, dass die Asiatische Goldkatze in höheren Lagen des Hugu-Kori-Waldgebiets vorkommt.

Unterhalb von 2052 m sind 12 von 14 Aufnahmen entstanden, die einen Hirten und seine Nutztiere zeigen (Bild auf Seite 15). Abholzung im Habitat von Wildtieren stellt die größte Bedrohung für Katzen und ihre Beutetiere dar. In jedem Hauhalt sind traditionelle Erdöfen sowohl zum Kochen und Heizen in Gebrauch, die große Mengen an Feuerholz verbrauchen (Bilder auf Seite 17). Sobald Hirten im Sommer und während des Monsuns ihre Herden auf höher gelegene Weiden treiben, werden sie dort vermutlich auch ihren täglichen Bedarf an Feuerholz durch vermehrten Holzeinschlag decken. Wir empfehlen daher die Förderung von verbesserten Kochstellen oder kostengünstigen Solarkochern, um den Holzeinschlag zu verringern.

Nach Aussagen von Einheimischen werden im Hugu-Kori-Waldgebiet hauptsächlich Vögel und Hirsche bejagt, was die Katzen indirekt bedroht, da ihre Beutegrundlage vermindert wird. Wir haben eine aus Steinen gebaute Falle gefunden (Bild auf Seite 17), in der Leoparden mit Fleisch geködert werden, und eine kleinere aus Holz gebaute, die zum Fangen von Vögeln dient. Wir erachten regelmäßige Patrouillen im Waldgebiet durch Personal des Annapurna Naturschutzgebietes für notwendig, um Wilderei unter Kontrolle zu halten.

1. Introduction

1.1 Background

Six felid species are found in Nepal's mid elevation hills ranging from 700–3000 m altitude including leopard *Panthera pardus,* clouded leopard *Neofelis nebulosa,* Asian golden cat *Pardofelis temminckii,* marbled cat *Pardofelis marmorata,* jungle cat *Felis chaus* and leopard cat *Prionailurus bengalensis*. Eurasian lynx *Lynx lynx* has been reported from 2745–5200 m altitude in the central and western Himalayas in 1995 (Baral and Shah 2008). Snow leopard *Panthera uncia* in Nepal is associated with steep, broken mountainous habitat in alpine and sub-alpine zones where vegetation is sparse (Ale 2002).

In the past 40 years, felid research focused on tigers in the country's lowlands (Sunquist 1981, Smith et al. 1998, Odden and Wegge 2005, Odden et al. 2010), and on snow leopards in the high-altitude Himalayas (Jackson 1996, Ale 2002). But little is known about the distribution and ecology of small felids in Nepal's mid-hill belt. There is clearly a substantial deficiency in baseline ecological data about these felids in the country, in spite of them playing an important role in the forest ecosystems regulating mammal and bird populations. As a result conservation status of these felids in most parts of the country is very poorly known.

1.2 Objectives of our project

With the present project we aimed to contribute to the knowledge about felids in Nepal's mid-hill belt by collecting baseline ecological data. We intended to assess the status of felids in the Hugu-Kori biodiversity hotspot inside the Annapurna Conservation Area, Nepal, with a focus on clouded leopard and Asian golden cat. Our objectives were to

- Assess the presence/absence, relative abundance and activity patterns of wild felids;
- Evaluate the prey base for felids in this area;
- Identify and document all the known and probable threats for felids and their prey species.

2. Project design

2.1 Study area

The Annapurna Conservation Area (ACA) was gazetted in 1992, and is located in the central Himalayas. With an area of 7,629 sq km it is the largest protected area in Nepal, and represents the Trans-Himalayan and mountain ecosystems. It covers tropical, temperate and alpine climatic regions, harbours 22 different forest types and 97 mammal species (Bhuju et al. 2007). The entire area is recognized as a global biodiversity hotspot (Myers et al. 2000), and is one among the important Global 200 Ecoregions (Olson and Dinerstein 1998).

The seasonal climate is dominated by the monsoon, which occurs between June and September. Annual rainfall in the southern Annapurna region is 3000 mm. Mid-hills in the ACA range from 1001 m to 3000 m altitude and comprise lower subtropical to upper temperate bioclimatic zones (NTNC 2009).

Photo 1: Typical mid-hill landscape

Mid-hills in the ACA range from 1001 m to 3000 m altitude and comprise lower subtropical to upper temperate bioclimatic zones (NTNC 2009). These mid-hills are steep and canyoned by myriads of precipitous gorges and ravines (Photo 1), burbling creeks and spectacular waterfalls coercing travelers to wander up hill and down dale on narrow trails.

Our study area was located in the Hugu-Kori forest in the eastern mid-hills of the ACA, south of the peaks of *Annapurna II* and *Lamjung Himal* (Fig. 1, Photo 2).

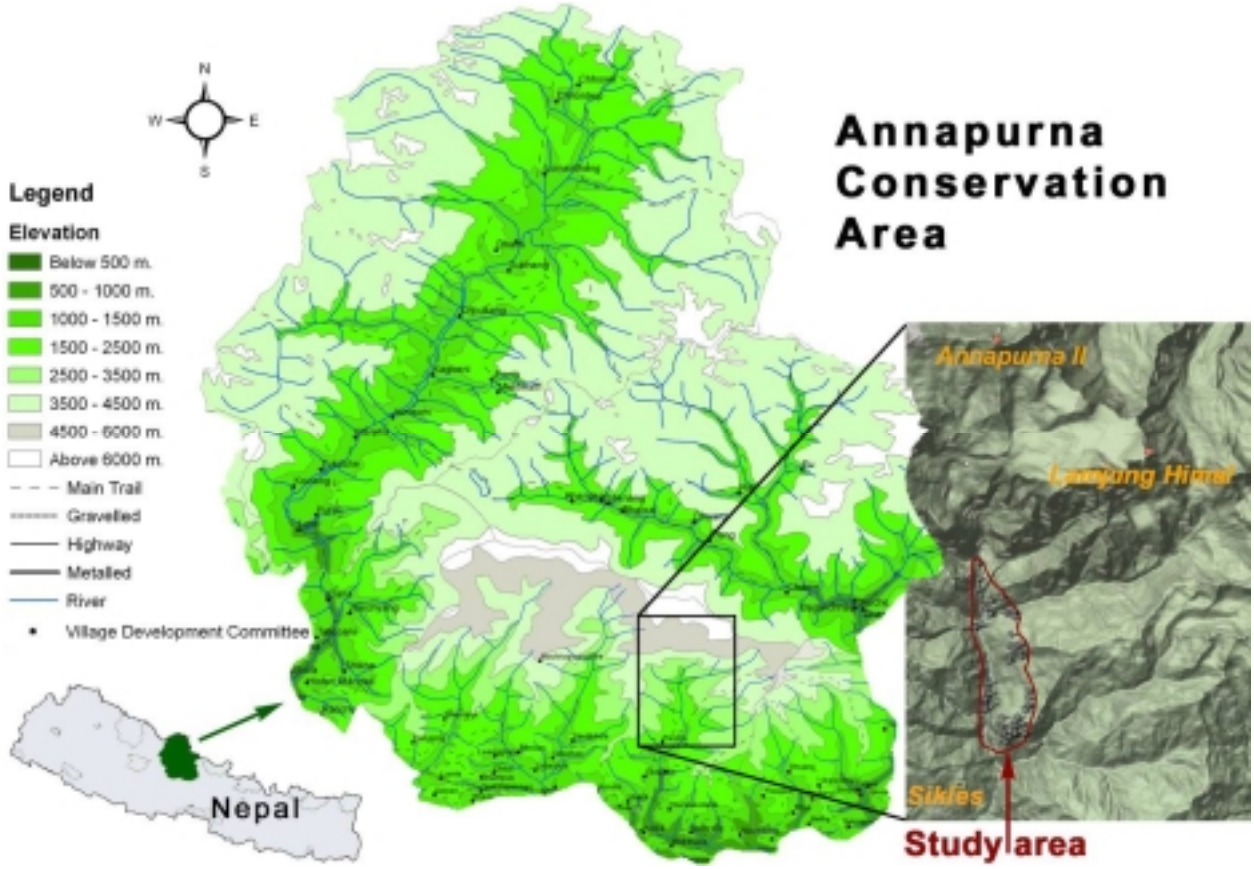

Fig. 1: Map of the ACA with study area marked in red

Photo 2: View to the north with *Lamjung Himal* in the background

The core area of our survey lies in the upper reaches of the *Madi River* that cuts a deep gorge between the hills (Photo 3). Our survey area comprised around 24 sq km stretching between 28°22.2'N / 84°7.4'E in the south to 28°26.9'N / 84°6.8'E in the north, and from 28°23.5'N / 84°8.2'E in the east to 28°25.2'N / 84°6.7'E in the west. We covered an elevation ranging from 1553 m to 2928 m in upper subtropical to upper temperate bioclimatic zones, where the vegetation is dominated by *Quercus glauca* and accompanied by *Rhododendron sp.*, *Ficus sp.*, *Himalayacalamus asper,* and *Daphne papyracea*. Various fern species form dense undergrowth. This mixed broadleaf forest is interspersed with shrub, patches of grassland and barren land along riparian corridors.

Photo 3: View across the *Madi River* to the south

This area is off the main trekking route, and was fairly undisturbed during the late winter season when the present study was conducted. The nearest village *Sikles* is located a one- to two-day's walk to the south at 1975 m altitude in west of *Madi River*.

The livelihood of local people is primarily based on livestock farming and agriculture (NTNC 2009). The land use pattern in the area around *Sikles* is provided in table 1.

Table 1: Land use pattern

Land type	covers
Forest	46.55%
Barren land	28.91%
Grazing land	8.16%
Agriculture	8.06%
Shrub land	7.90%
Landslide	0.42%

Source: NTNC 2009

It is common practice for the human inhabitants of the ACA to use trees for timber and firewood, and to collect non-timber forest products. Hunting, firewood collection and seasonal livestock herding in high elevation pastures cause the main disturbances in the forests of this area (NTNC 2009). Nowadays, tourism is increasing, and in major villages of the region some families provide home-stays.

2.2 Methods

2.2.1 Reconnaissance survey

We first delineated the area below 3000 m using a topographical map of the study area. During a reconnaissance survey from 22 to 28 April 2011, we visited the delineated area to select camp sites (Photo 4) and potential sites for deploying camera trap units for intensive camera trapping. We hired local people as guides and walked a total distance of 100 km

Photo 4: Camp site on the way to the Hugu glacier at 28°25.439'N / 84°6.844'E

during this time. Along wildlife trails we looked for signs of carnivores and their prey species such as scat and scrape marks, and selected potential trap stations where signs were abundant.

Apart from this, we carried out informal discussions with key informants in order to assess the presence of the targeted species in the study area, and the local people's opinion about them.

2.2.2 Camera trapping survey

Our survey was the first camera trapping survey conducted in this area. To detect and record wildlife, we employed 12 YetiCam units equipped with Sony DSC-P32 cameras and three Reconyx RM45 Rapidfire trail cameras. Camera trapping was carried out from 18 January to 20 February 2012, and was the primary method used.

We walked transects of different lengths in the study area and looked for felid signs along both wildlife and human trails. We searched five meter belts for scat, pugmarks, and other indirect signs of the targeted species, and selected trap sites based on sign abundance indicative of frequent activity of felids to maximize the capture probability (Karanth 1995). We placed the camera traps close to sites with felid scat, pugmarks, or scrapes and mounted them at a height of 30-60 cm above ground. We kept the distance between camera traps at 100–1600 m depending on the accessibility of suitable trees. We used a Garmin GPS 60CSX unit to record coordinates, elevation and slope of camera trap locations, and noted their habitat characteristics and crown coverage. All camera traps were operational 24 hours per day and recorded time and date for each exposure. We monitored them regularly to replace batteries and check on captured images.

Whenever possible we took photographs of directly observed species.

Field surveys were complemented by interviews with local residents. We used semi-structured questionnaires to acquire information from inhabitants of settlements adjacent to our study area. Emphasis was given to informal discussions, during which we modified questions as the situation demanded. We documented anecdotal evidences about the status of the felids and threats associated with their survival.

2.3 Data Analysis

We counted only independent photographs of a particular species as valid. The independence of photographs was defined as (1) successive photographs of different individuals, (2) consecutive photographs of the same individual taken more than 30 minutes apart, and (3) non-consecutive photographs of individuals (O'Brien et al. 2003). Photos of more than one individual in the frame were counted as one detection for the species. We used time data of the camera trap images to analyse the activity patterns of the recorded felids.

On the basis of independent photographs we calculated

- the capture rate (CR), which is defined as the number of trap nights required to obtain one photograph of a species (Carbone et al. 2001).
- the Relative Abundance Index (RAI) defined as the number of photo captures obtained per 100 trap nights (Henschel and Ray 2003).

In our analysis of data collected during interviews, we considered information regarding human-wildlife conflict as most important for assessing threats faced by felids in the area.

3. Results

We recorded 17 wild mammal species during interviews, and transect and camera trapping surveys. A summary of our results is presented in table 2.

Table 2: Wild mammals recorded during the surveys

	Species	 Camera trap	 Sighting	 Track	 Call	 Scat / Pellet	 Interview
1.	Clouded leopard *Neofelis nebulosa*	✓					
2.	Indian leopard *Panthera pardus*	✓		✓		✓	✓
3.	Leopard cat *Prionailurus bengalensis*	✓		✓		✓	✓
4.	Large Indian civet *Viverra zibetha*	✓					
5.	Yellow-throated marten *Martes flavigula*	✓	✓	✓		✓	✓
6.	Golden jackal *Canis aureus*						✓
7.	Asiatic black bear *Ursus thibetanus*	✓		✓		✓	✓
8.	Barking deer *Muntiacus muntjak*	✓	✓	✓	✓	✓	✓
9.	Himalayan serow *Capricornis thar*	✓		✓	✓	✓	✓
10.	Himalayan tahr *Hemitragus jemlahicus*			✓		✓	✓
11.	Goral *Naemorhedus goral*					✓	✓
12.	Assamese macaque *Macaca assamensis*	✓	✓		✓	✓	✓
13.	Grey langur *Semnopithecus schistaceus*		✓			✓	✓
14.	Himalayan crestless porcupine *Hystrix brachyura*	✓					✓
15.	Orange-bellied Himalayan squirrel *Dremomys lokriah*	✓	✓	✓			✓
16.	Giant flying squirrel *Petaurista philippensis*						✓
17.	Mouse *Apodemus sp.*	✓	✓				

3.1 Interviews

We conducted informal discussions with four groups, one with personnel of the *National Trust for Nature Conservation* ACA Project office in *Sikles*, and one with local inhabitants of *Sikles*. With residents of *Hugu* village, we organized two more discussion groups. All our interviews were focused on the presence of felid species in the area. Participants confirmed the presence of leopard and leopard cat, but none of them had ever sighted a clouded leopard or an Asian golden cat in the area.

3.2 Transect survey

During January and February 2012, we walked a total of eight transect routes with lengths of 194 meters to 4080 meters, amounting to 11454 m. These transects represent an elevation ranging from 1623 meters to 3041 meters above sea level. Details of the transect routes are provided in table 3.

Table 3: Transect routes

Transect no.	GPS coordinates		Elevation range (in m)	Habitat	Route	Aerial distance
	Start	End				
1.	28°23.239' N 84°06.926' E	28°25.434' N 84°06.826' E	1623 – 2006	Forest	Idhi to Hugu	4080 m
2.	28°25.434' N 84°06.826' E	28°26.044' N 84°06.849' E	2006 – 2299	Forest	Hugu to Tishidhu	1130 m
3.	28°26.044' N 84°06.849' E	28°26.148' N 84°06.831' E	2299 – 2357	Forest	Tishidhu to Upper Tishidhu	194 m
4.	28°25.434' N 84°06.826' E	28°25.909' N 84°07.421'E	2006 – 2477	Forest	Hugu to Salema	1310 m
5.	28°25.434' N 84°06.826' E	28°25.239' N 84°07.707' E	2006 – 2508	Forest	Hugu to Labi	1480 m
6.	28°24.467' N 84°07.915' E	28°24.846'N 84°08.201' E	2539 – 3041	Forest	Labi to Sedanda	845 m
7.	28°24.416' N 84°07.963' E	28°24.142' N 84°08.042' E	2530 – 2519	Forest	Labi to Talka	525 m
8.	28°22.820' N 084°07.711' E	28°23.676' N 84°08.197' E	2306 – 2371	Forest	Talka to Lower Talka	1890 m

During transect walks, we sighted two squirrels and recorded scat and pellets, tracks, scrape marks and calls of seven mammal species: leopard, leopard cat, Asiatic black bear, yellow-throated marten, barking deer, Himalayan serow and Assamese macaque. Signs recorded are presented in table 4.

Table 4: Signs recorded during transect walks

Transect	Route	Species / Signs			Scrape marks	
1.	Idhi to Hugu	Leopard	4	1	4	
		Leopard cat	24			
		Yellow-throated marten	15			
		Barking deer	1			

Transect	Route	Species Signs			Scrape marks	
2.	Hugu to Tishidhu	Leopard		1		
		Yellow-throated marten	2			
		Barking deer	6	1		
		Himalayan serow		1		
3.	Tishidhu to Upper Tishidhu	Assamese macaque	1			
		Asiatic black bear	1			
		Barking deer	8			
		Himalayan serow	6			
4.	Hugu to Salema	Leopard	1			
		Leopard cat		1		
		Yellow-throated marten	4			
		Assamese macaque	1			
		Barking deer	15			
		Himalayan serow	2		1	
5.	Hugu to Labi	Leopard cat	5	5		
		Barking deer	4			
		Himalayan serow	5			
6.	Labi to Sedanda	Leopard			2	
		Yellow-throated marten	11			
		Asiatic black bear	1		1	
		Barking deer	10			
		Himalayan serow	2	2		
7.	Labi to Talka	Leopard cat	3			
		Unidentified felid	1			
		Yellow-throated marten	22			
		Assamese macaque	2			
		Barking deer	6			
8.	Talka to Lower Talka	2 squirrels sighted				
		Leopard cat	3	2		
		Yellow-throated marten	13			
		Asiatic black bear	1			
		Barking deer	9			
		Himalayan serow	1			

We recorded 43 leopard cat signs and 12 leopard signs in 11454 m walked. This finding suggests that with a relative abundance of 3.75 signs per 1000 m, leopard cat is the most abundant felid in our study area, followed by leopard with 1.05 signs per 1000 m.

During opportunistic excursions we recorded three different-sized felid pugmarks on moist ground:

- Tracks measuring 8 cm in length, with a 4.8 cm long main pad. According to Henschel and Ray (2003), a full-grown leopard has a track that measures 7.5–11 cm in width and length, with the main pad having a length of 4–7.5 cm.
- Tracks measuring 2.5–3 cm in length and width. According to Lēkhakun and McNeely (1977) these small tracks are of leopard cat.
- The intermediate track was 4.2 cm long, with a main pad length of 2.4 cm indicating that this cat is smaller than a leopard and bigger than a leopard cat.

3.3 Camera trapping survey

We set up camera traps in a total of 59 sites. Our sample effort was concentrated in elevations of 2000–2500 m in the hills east of the *Madi River*. Details are presented in table 5.

Table 5: Sampling effort

Elevation range	**West** of *Madi River*		**East** of *Madi River*	
	Sites	Trap nights	Sites	Trap nights
1577–1999 m	5	29	3	7
2003–2494 m	6	27	35	258
2510–2928 m	1	6	9	43
Total	12	62	47	308

The total sampling effort of 370 trap nights yielded 1500 captures resulting in a total of 332 independent captures (ICs), out of which 201 ICs (60.54% of all) account for wildlife listed in table 6.

Table 6: Wildlife recorded by camera traps

	Total images	ICs	% of all ICs	CR*	RAI**
Barking deer	190	51	15,36%	6.63	15.09
Birds		49	14,76%	6.90	14.50
Leopard cat	105	32	9,64%	10.56	9.47
Leopard	200	20	6,02%	16.90	5.92
Mouse *Apodemus sp.*	22	12	3,61%	28.17	3.55
Large Indian civet	14	11	3,31%	30.73	3.25
Yellow-throated marten	20	10	3,01%	33.80	2.96
Not identifiable fury species	17	5	1,51%		
Himalayan serow	16	4	1,20%	84.50	1.18
Himalayan crestless porcupine	8	3	0,90%	112.67	0.89
Asiatic black bear	4	3	0,90%	112.67	0.89
Orange-bellied Himalayan squirrel	3	1	0,30%	338.00	0.30
Clouded leopard	1	1	0,30%	338.00	0.30
Assamese macaque	1	1	0,30%	338.00	0.30
Total		201	60,54%		

* CR = capture rate (trap nights per IC); ** RAI = Relative Abundance Index (ICs per 100 trap nights)

The remaining ICs comprised livestock (10 ICs, 3.04%), dogs (3 ICs, 0.91%) and local people (1 IC, 0.30%); 43 ICs (13.68%) were triggered by weather conditions such as wind, rain, snow,

3.3.1 Felids recorded

We obtained one photograph of a **clouded leopard** on 8 February at 19:11 at an altitude of 2174 meters at 28°22.870'N and 84°7.363'E (Photo 5). The individual was taken 78 minutes after sunset (17:53) in a mixed broadleaved forest that is dominated by *Quercus glauca* and accompanied by *Rhododendron sp., Ficus sp., Himalayacalamus asper* and *Daphne papyracea.*

Photo 5: Clouded leopard in our study area

Leopards were photographed between 25 January and 20 February. We did not obtain any capture west of *Madi River*. East of *Madi River*, 17 ICs were taken at the elevation range of 2128–2494 m in 273 trap nights (CR 16.05, RAI 6.23), and the remaining three ICs were taken in 42 trap nights above 2504 m (CR 14, RAI 7.14).

Of 20 ICs, only one was taken during day time at 14:34–14:51; four ICs were taken between sunset and 36 minutes after sunset; eight ICs were taken at night between 22:15 and 4:30; and seven ICs were taken from 38 minutes before sunrise to 46 minutes after sunrise. The males in photos 6 and 7 differ in facial markings and rosette pattern.

Photo 6: Leopard in the afternoon of 25 January

Photo 7: Leopard at an altitude of 2449 m

Leopard cats were photographed between 21 January and 19 February. We obtained two ICs in 53 trap nights (CR 26.5, RAI 3.77) in the west of *Madi River*, both below an elevation of 1670 m. Of 30 ICs taken in the hills east of the river, 26 ICs were taken in 273 trap nights (CR 10.5, RAI 9.52) in the elevation range of 2019–2494 m, and four ICs in 42 trap nights (CR 10.5, RAI 9.52) at altitudes of 2568–2860 m.

We did not obtain any capture during day-light hours. Four ICs were taken 57 minutes before to 92 minutes after sunset, and 25 ICs after dark between 19:54 and 5:51. Three ICs were taken 25–52 minutes before sunrise (Photo8).

Photo 8: Leopard cat in the early morning of 7 February

3.3.2 Prey species recorded

Between 19 January and 19 February, we obtained 54 ICs of ungulates, of which barking deer was the most abundant (CR 6.76, RAI 14.79) followed by Himalayan serow (CR 84.5, RAI 1.18). Ungulates were photographed both during days and at night (Photos 9 and 10).

Photo 9: Barking deer

Photo 10: Himalayan serow

Among the rodents recorded mice were the most abundant (CR 28.17, RAI 3.55), followed by Himalayan crestless porcupine (CR 112.76, RAI 0.89) (Photo 11) and Orange-bellied Himalayan squirrel (CR 338, RAI 0.30). Birds recorded include kalij pheasant (Photo12).

Photo 11: Himalayan crestless porcupine

Photo 12: Kalij pheasant

Assamese macaque was only once photographed on the ground. But we several times sighted and heard a group in the canopy of the forest and detected scat on the ground.

3.3.3 Human encroachment recorded

We recorded the highest level of human disturbance in elevations below 2052 m, where all ten ICs of local herders with their livestock were captured between 29 and 30 January. Five of these show a large herd of goats (Photo 13) accompanied by a herder travelling in riverine area from their camp site at 2021 m altitude to pasture land and back.

One dog and the first local man were photographed at an elevation of 2162 m on 18 and 19 March.

Photo 13: Goats crossing a tributary of the *Madi River* in the north-east of the Hugu-Kori forest

4. Concluding discussion

The felid community in the Hugu-Kori forest

Our survey in the Hugu-Kori forest of the ACA revealed the presence of a felid community comprising leopard cat, leopard, and clouded leopard. Camera trapping results indicate that these felids prefer forested habitat in elevations above 2000 m, where our capture rate was higher than below this altitude. Of 53 ICs depicting felids, we obtained 44 ICs in 273 trap nights (CR 6.20, RAI 16.12) in the elevation range of 2019–2494 m, and seven ICs in 42 trap nights (CR 6, RAI 16.67) above 2500 m. Below 2000 m only two ICs were taken in 53 trap nights (CR 12.5; RAI 3.77).

In end of January it was snowing for a few days at elevations above 2000 m, with temperatures around freezing point in the early morning. All ICs of felids obtained above 2500 m were taken during the first two weeks of February, when snow had melted but temperatures in the night were still below 5ºC (41ºF). Rising temperatures and increasing availability of food may entice both felids and their prey to use higher elevations during spring, summer and monsoon seasons.

Clouded leopard and Asian golden cat

The **clouded leopard** was first reported in Nepal in 1853 (Hodgson 1853). The felid was thought to be extinct in the country, until in the late 1980s four specimens were found in southern Nepal and near the city of Pokhara (Dinerstein and Mehta 1989), which borders the ACA to the south. Our photographic record is the first of a live individual within this protected area and confirms the felid's distribution to central Nepal.

The low capture rate of one photo in 338 trap nights does not necessarily reflect low numbers of the felid, but rather a decreased probability to capture it along wildlife trails that are frequented by leopards, the top predator of the area. The clouded leopard is known to use a dimension that was not covered in our survey, namely trees higher up than 60 cm above ground. Hemmer (1968) describes the clouded leopard as the most talented climber among the cats that is capable of supination: by bending its hind paws and long tail around branches the felid can even hang down from these branches with its back to the ground; the long tail enables it to skilfully balance on thin branchings of tree limbs. Therefore, we consider higher capture rates probable by implementing a camera trapping design that incorporates surveying of tree trunks and canopy.

The presence of **Asian golden cat** *Pardofelis temminckii* in the Hugu-Kori forest remains uncertain. We could not match the intermediate-sized felid tracks found at an elevation around 2400 m with certainty to Asian golden cat or clouded leopard, despite efforts to compare measurements of these tracks with those of captive Asian golden cats and clouded leopards kept in the Wuppertal Zoo.

Nepal is believed to be the westernmost range of the felid since hunters had caught a male individual in a dense forest in the country's mid-hills in 1829 that was brought alive to the British Resident Brian H. Hodgson (Hodgson 1831). One sighting was reported in 1987 from Langtang National Park, located further east in the Himalayas, at an altitude of around 2700 m (Pralad Yonzon, *pers. comm*.). In May 2009, a melanistic Asian golden cat was photographed at an altitude of 2517 m in the Makalu-Barun National Park, located in the eastern Himalayas of Nepal. This record was the first authentic evidence of the felid's presence in the country since 1829 (Ghimirey and Pal 2009). In 2010, the presence of Asian golden cats was confirmed in India's Khangchendzonga Biosphere Reserve in Sikkim at elevations of 1980–3960 m (Bashir et al. 2011). Since our sample effort was limited to 42 trap nights in the elevation range of 2510–2860 m, we do not preclude the probability that the felid occurs at higher elevations in the Hugu-Kori forest as well.

More extensive camera-trapping efforts are needed to assess the status and ecology of both clouded leopard and Asian golden cat as well as threats to their survival assessed via observations and interviews in this area and over larger areas of Nepal.

Habitat disturbance and threats

During our field work, we recorded the highest level of human disturbance in elevations below 2052 m, where 12 of 14 ICs depicting local people and livestock were captured between 29 and 30 January. Herders do not use higher elevated pastures during winter and spring. But four temporary campsites at altitudes of 2208–2541 m indicate that these are in use during the summer and monsoon months. Therefore it will be thrilling to survey this area at a later time of year and document, how the increasing presence of humans and their livestock affects the felid community in the Hugu-Kori forest.

The premier threat for felids and prey species is the deforestation of their habitat. In the cold season, *Sikles* residents collect fuelwood mainly in the vicinity of the village (Photos 14 and 15).

Photo 14: Residents of *Sikles* collecting fuelwood

Photo 15: Fuelwood stacks of one household

The local man captured in our study area on 18 March carried a saw and went into the forest above our camp site located at 2208 m altitude, presumably to prepare logging. Cutting and collecting of fuelwood in wildlife habitat is likely to increase once herders start using higher elevated pasture land.

According to local people, hunting of birds and deer is prevalent in the area. During excursions in our study area, we found one stone trap set up for baiting large carnivores (Photo 16), and a smaller wooden one for catching birds.

Photo 16: Stone trap for catching large carnivores

Recommendations

We highly recommend regular patrolling of prime wildlife habitat by ACA project personnel to keep human encroachment and poaching at bay. Monitoring the activities of herders in higher elevated pasture land is essential, especially from spring onwards through summer and monsoon seasons.

In every household, traditional earth ovens are used for both cooking and keeping houses warm. They are kept burning day and night, and consume large quantities of fuelwood. To reduce the logging pressure on the forest, we recommend the promotion of cooking stoves that need no or less fuelwood, such as solar cookers. Arveson (2012) describes low-cost solar cookers that easily reach temperatures high enough to pasteurize water or cook rice. They drive down fuel costs and reduce environmental and health impacts from burning fuels.

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6. Annex

We attach an article about the clouded leopard in our study area that is submitted for publication in Cat News.

An article about small carnivores in the Hugu-Kori forest is in process, and another one about the felids in the study area is planned.

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Clouded Leopard (*Neofelis nebulosa*) camera trapped in the Annapurna Conservation Area, Nepal

During a camera trapping survey in the Annapurna Conservation Area, Nepal, a clouded leopard was photographed on 8 February 2012 at 7:11 PM. The felid was captured at an altitude of 2174 meters in a mixed broadleaved temperate forest dominated by *Quercus glauca.*

The clouded leopard *Neofelis nebulosa* was first reported in Nepal in 1853 (Hodgson 1853). The felid was thought to be extinct in the country, until in the late 1980s four specimens were found in southern Nepal and near the city of Pokhara (Dinerstein and Mehta 1989), which borders the Annapurna Conservation Area (ACA) to the south. Our photographic record (Fig. 1) is the first of a live individual within this protected area and confirms the felid's distribution to central Nepal.

Fig 1: Clouded leopard in the ACA (Photo Friends of Nature).

With an area of 7,629 sq km the ACA is the largest protected area in Nepal. Covering tropical, temperate and alpine climatic regions it harbours 22 different forest types (NTNC 2009). The entire area is recognized as a global biodiversity hotspot (Myers et al. 2000). Mid-hills in the ACA range from 1001 m to 3000 m altitude and comprise lower subtropical to upper temperate bioclimatic zones (NTNC 2009). These mid-hills are steep and canyoned by precipitous gorges.

Our survey area was located in the Hugu-Kori forest in the eastern mid-hills of the ACA, south of the peaks of *Annapurna II* and *Lamjung Himal* (survey area marked in red in Fig. 2). We covered an elevation ranging from 1553 m to 2928 m in lower subtropical to upper temperate bioclimatic zones. This area is off the main trekking route, and was fairly undisturbed during the late winter season when the present study was conducted.

Camera trapping was carried out from 18 January to 20 February 2012, using 15 camera traps placed along wildlife trails. The total sampling effort of 338 trap nights yielded one picture of a clouded leopard taken on 8 February at 7:11 PM at an altitude of 2174 meters at 28°22.870'N and 84°7.363'E. The individual was photographed 1h 18min after sunset (5:53 PM) in a mixed broadleaved forest that is dominated by *Quercus glauca* and accompanied by *Rhododendron sp., Ficus sp., Himalayacalamus asper* and *Daphne papyracea.* Various fern species form

dense undergrowth. A small settlement comprising two households is one-hour walking distance downhill from this site. The nearest village *Sikles* is located a day's walk to the south across the *Madi River*.

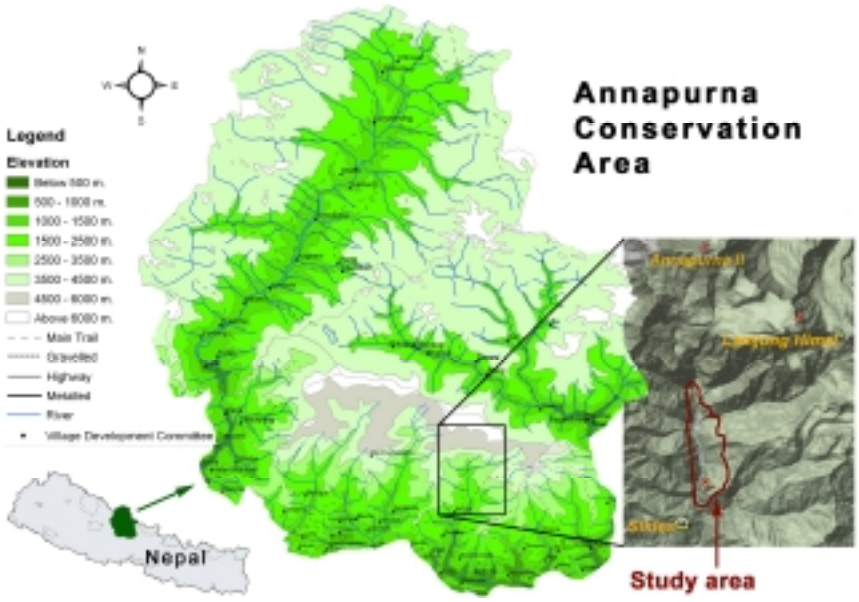

Fig. 2: Map of the ACA with study area marked in red

Other felids photographed include Indian leopard *Panthera pardus* and leopard cat *Prionailurus bengalensis*. We recorded Assamese macaque *Macaca assamensis*, Indian barking deer *Muntiacus muntjak,* Malayan porcupine *Hystrix brachyura,* Orange-bellied Himalayan squirrel *Dremomys lokriah,* and kalij pheasant *Lophura leucomelanos*, which constitute potential prey species for clouded leopards. We frequently observed calls and droppings of hill partridge *Arborophila turqueola* and satyr tragopan *Tragopan satyra*.

Hunting, firewood collection and seasonal livestock herding in high elevation pastures cause the main disturbances in the forests of this area. It is common practice for the human inhabitants of the ACA to use trees for timber and firewood, and to collect non-timber forest products (NTNC 2009). According to local people, hunting of birds and deer is prevalent in the area. This hunting pressure may deplete clouded leopard prey species.

The clouded leopard is classified as a nationally endangered species and listed as a protected mammal in Nepal (Jnawali et al. 2011). More extensive camera-trapping efforts are needed to assess the clouded leopard's status, ecology as well as threats to its survival assessed via observations and interviews in this area and over larger areas of Nepal.

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