Short Communication

Recovery of snow leopard *Uncia uncia* in Sagarmatha (Mount Everest) National Park, Nepal

Som B. Ale, Pralad Yonzon and Kamal Thapa

Abstract From September to November 2004 we conducted surveys of snow leopard *Uncia uncia* signs in three major valleys in Sagarmatha (Mount Everest) National Park in Nepal using the Snow Leopard Information Management System, a standardized survey technique for snow leopard research. We walked 24 transects covering *c*. 14 km and located 33 sites with 56 snow leopard signs, and 17 signs incidentally in other areas. Snow leopards appear to have re-inhabited the Park, following their disappearance *c*. 40 years ago, apparently following the recovery of Himalayan tahr *Hemitragus jemlahicus* and musk deer *Moschus chrysogaster* populations. Taken together the locations of all 73 recent snow leopard signs indicate that the species is using predominantly grazing land and shrubland/open forest at elevations of 3,000–5,000 m, habitat types that are also used by domestic and wild ungulates. Sagarmatha is the homeland of *c*. 3,500 Buddhist Sherpas with >3,000 livestock. Along with tourism and associated developments in Sagarmatha, traditional land use practices could be used to ensure coexistence of livestock and wildlife, including the recovering snow leopards, and ensure the wellbeing of the Sherpas.

Keywords *Hemitragus jemlahicus*, Himalayan tahr, Mount Everest, Nepal, Sagarmatha National Park, snow leopard, *Uncia uncia*.

The upper valleys of the 1,148 km² Sagarmatha (Mount Everest) National Park in east Nepal (Fig. 1), the world's highest National Park, are dominated by snow peaks, glaciers and barren moraines with sparse vegetation. The more verdant lower valleys, however, provide habitat for ungulates that include Himalayan tahr *Hemitragus jemlahicus* and musk deer *Moschus chrysogaster*. Oral history and a report by Fleming (undated) suggest that snow leopards *Uncia uncia* were extirpated from the Nepal side of the Mount Everest complex in the 1960s. Following the establishment of the Park in 1976 the population of Himalayan tahr increased, and by the late 1980s transient snow leopards were visiting the Park's Gokyo valley from contiguous Tibet, thus suggesting that snow leopards could re-establish their population in the Park (Ahlborn & Jackson, 1987).

From October to November 2004 we conducted sign surveys in a total survey area of 58.3 km² in three major valleys, Namche, Phortse and Gokyo, to assess the status and distribution of snow leopards in the Park. We also interviewed 71 herders to collect information on whether they had lost any animals to snow leopards. We followed the survey protocol of the Snow Leopard Information Management System (Jackson & Hunter, 1996). Transect routes comprised landforms such as ridge lines and bases of cliffs where snow leopard signs were likely to be found. In total we walked 24 transects covering *c*. 14 km and located 33 sites with 56 signs (Table 1). The Phortse valley had a significantly higher mean density of snow leopard sign sites per km of transect compared to Namche and Gokyo (Kruskal-Wallis $H = 7.29$, df = 2, $P = 0.026$).

We also located 17 further snow leopard signs incidentally in places other than on the transects, and located relict sign sites (with signs made by snow leopard or other felid species) in Phortse and Namche, but not in Gokyo. Scrapes (59%) were by far the most common sign, which together with faeces constituted >90% of signs encountered. We encountered no signs of grey wolf *Canis lupus* or common leopard *Panthera pardus*, but found evidence of medium- and small-sized predators such as golden jackal *Canis aureus* and red fox *Vulpes vulpes* that may prey on game birds and small rodents. Taken together the locations of all 73 recent snow leopard signs indicated that the species is using

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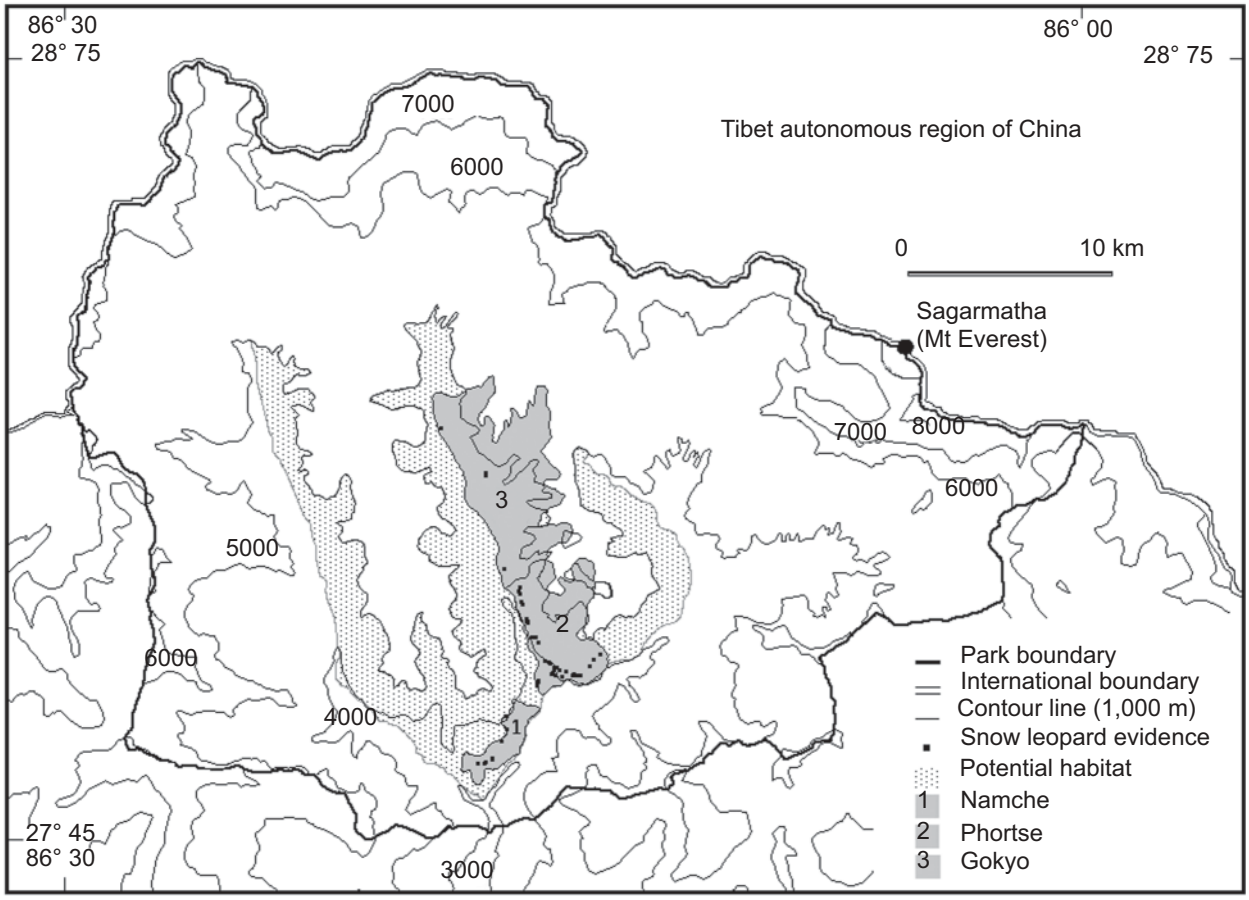

Fig. 1 Sagarmatha National Park, east Nepal, showing areas of potential snow leopard habitat, the three areas surveyed, and the locations of snow leopard signs (see text for details).

Table 1 Number of sign sites, signs, and signs that were scrapes (with mean densities per km of transect in parentheses) in each of the three valleys surveyed in Sagarmatha National Park (Fig. 1).

Location	Total transect length (km)	No. sign sites (mean km^{-1})	No. signs (mean km^{-1})	No. scrapes (mean km^{-1})
Namche	4	3 (0.84)	7 (1.95)	1 (0.28)
Phortse	5	25 (4.77)	43 (8.20)	26 (4.96)
Gokyo	5	5 (1.10)	6 (1.32)	6 (1.32)
Total (mean)	14	33 (2.46)	56 (4.18)	33 (2.46)

predominantly grazing land and shrubland/open forest ($\chi^2 = 420.6$, df = 3, $P < 0.01$; Fig. 2). Domestic and wild ungulates also use these habitats, which are at elevations of 3,000 – 5,000 m.

It appears that snow leopards now inhabit all three surveyed valleys. We located signs in 58% of the 24 transects, with averages of 2.5 sites, 4.2 total signs and 2.5 scrapes km^{-1}, in contrast to the previous survey in 1987 in which 13% of the 31 transects had signs, with 0.7 sites, 2.6 total signs and 0.5 scrapes km^{-1}, and only in Gokyo valley (Ahlborn & Jackson, 1987). This suggests that snow leopards have increased not only their abundance but also their range in Sagarmatha National Park. It is plausible that the recovery of Himalayan tahr and musk deer populations following the gazetting of the National Park (Green, 1993) have enabled snow leopards to return. Since the 1990s the local reproductive rate of Himalayan tahr, however, has been low (Lovari, 1992) and it is possible that predation by snow leopards could have contributed to reduced recruitment in the tahr population in Sagarmatha. This requires further study.

Lodging of formal complaints to government liaison offices about loss of livestock to snow leopards in Sagarmatha is almost non-existent, although incidences of livestock predation by snow leopards have been reported. In Phortse, for example, 1.9% of livestock was taken by snow leopards in 2004. This mortality rate is similar to that in Annapurna, Nepal (Jackson *et al.*, 1996) and in India (Mishra, 1997). The snow leopard is considered as one of the mountain deities by the Sherpas, who believe that snow leopards kill

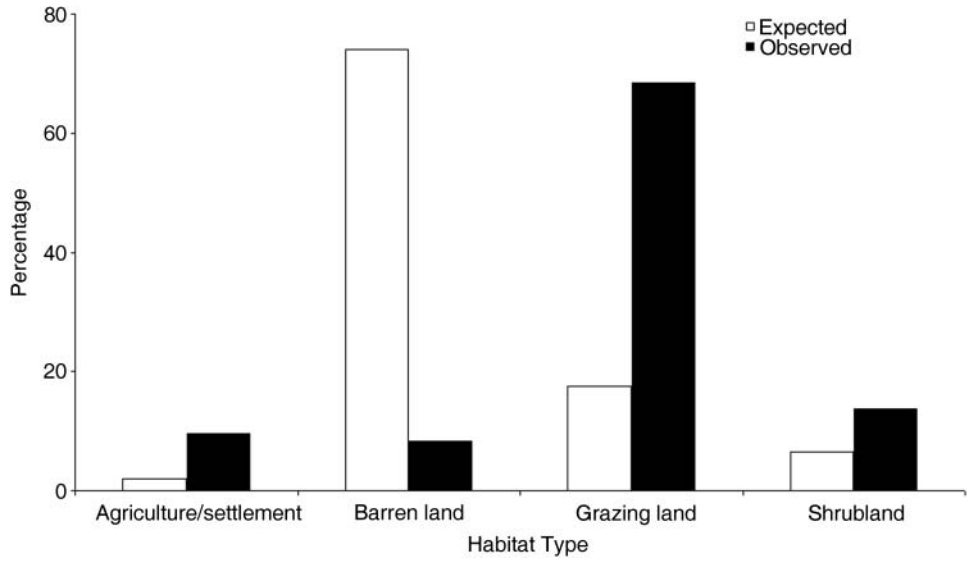

Fig. 2 Percentage observed and expected snow leopard habitat use (as determined from the occurrence of signs, see text for details) in the four main habitat types in Sagarmatha National Park (Fig. 1).

livestock only because of negligence in appeasing these deities. This religious belief is encouraging for the long-term survival of snow leopards in Sagarmatha, as there is unlikely to be retribution when livestock are predated.

Local herders fear wolves more that snow leopards because wolves are capable of predating even adult yaks. Wolves may now be absent in Sagarmatha, and the last was killed in the 1980s (Stevens, 1993). Nagpa-La, a high pass >5,700 m, may be a migration and dispersal route for wolves and snow leopards between Nepal and Tibet. However, wolves have not returned to Sagarmatha from Tibet, which suggests they may have also become more scarce in Tibet. Elsewhere snow leopards and wolves are sympatric over the entire global range of snow leopards.

Sagarmatha is the home of *c*. 3,500 Buddhist Sherpas with >3,000 livestock. Along with subsistence farming and animal husbandry, the Sherpas previously made regular excursions via the Nagpa-La into Tibet to barter salt, wool and cattle. This ancient trade was disrupted when Tibet became an autonomous region of China. Visitors to Sagarmatha increased from *c*. 1,400 in 1972/1973 to >20,000 in 2004, and increased affluence resulting from this tourism may be resulting in pressure on local resources.

Sherpas apparently appreciate the presence of snow leopards in Sagarmatha, and the leopards do not currently present a threat to the Sherpas' livelihoods. However, if snow leopards start supplementing their diets with livestock beyond the tolerance of herders, it is likely that there will be reprisals, as elsewhere in the Himalayas (Jackson *et al.*, 1996; Mishra, 1997; Schaller, 1998). It is not known how many Himalayan tahr are required for the persistence of snow leopards in Sagarmatha. However, a blue sheep *Pseudois nayaur* population (blue sheep are similar in size to Himalayan tahr) of 150–200 with an annual increment of 15% can support one wolf or one snow leopard if the population lacks other mortality causes such as poaching (Schaller, 1998). Research on the population density of Himalayan tahr and other potential snow leopard prey in Sagarmatha is required to determine how many snow leopards the area could support.

Sherpas are slowly losing their traditional lifestyles but until recently maintained land use practices with minimal impacts on local resources and wildlife (Bjonness, 1980; Brower, 1991; Nepal, 2003). Along with tourism and associated developments in Sagarmatha traditional land use practices, acquired over many generations, could be used to ensure coexistence of livestock and wildlife, including the recovering snow leopards, and ensure the wellbeing of the Sherpas.

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Biographical sketches

Som B. Ale has been involved for several years in research and conservation of large mammals, including snow leopards and their prey species, in Nepal. His current interest is in combining conventional wildlife techniques with the concepts of ecology to understand the patterns of distribution and abundance of animals.

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