Winter home range of snow leopards in Népal

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Summary.– Because of their low densities, sparse distribution, elusive behavior, and the precipitous habitat they occupy, snow leopards (*Uncia uncia*) have been the subject of limited study.This study contributes to that limited database with an investigation of the winter home range of 3 radio-collared snow leopards (2 females and 1 male) in the Annapurna Conservation Area, Nepal. Winter home ranges varied from 13.9-22.3 km^2 ($\bar{x}$ = 19.1). Home ranges overlapped extensively within and between sexes, and an area of 8.1 km^2 in the core study site was shared by all three leopards.

Résumé.– A cause de leur densité peu élevée, leur distribution éparpillée, leur comportement insaisissable, et leur habitat montagneux, les panthères des neiges (*Uncia uncia*) ont été l'objet de peu d'études. Dans cette étude, le domaine d'hiver de trois panthères des neige équipées de colliers-émetteurs (2 femelles et 1 mâle) dans la zone de conservation de l'Annapurna, au Népal, a été mesuré. Les domaines d'hiver varient de 13.9 à 22.3 km^2 ($\bar{x}$ = 19.1 km^2). Les domaines se recouvrent de façon extensive aussi bien entre animaux de même sexe qu'entre animaux de sexes différents, et une superficie de 8.1 km^2 au centre de la zone d'étude a été partagée par les panthères étudiées.

INTRODUCTION

Elusive habits, low densities, and remoteness of their mountainous habitat make ecological studies of snow leopards difficult, and consequently, they have been the subject of limited study. Prior to studies by Ahlborn and Jackson (1988), Chundawat (1990, 1992), Jackson and Ahlborn (1988, 1989), Koshkarev (1989), Oli (1991, 1994), Oli *et al.* (1993, 1994), and Schaller *et al.* (1994), our knowledge of the ecology of snow leopards had been based on anecdotal accounts of opportunistic observations or field surveys.

Although few reliable estimates of snow leopard numbers are available (Jackson and Ahlborn 1989 ; Oli 1994), field surveys indicate that their numbers are declining in many areas, and there is a global concern to protect the remaining populations (Anony-

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mous 1988 ; Taber 1988 ; Fox 1994). Knowledge of home range has significant management implications, but we have limited understanding of this aspect of snow leopard ecology (Jackson and Ahlborn 1989 ; Chundawat 1990 ; Schaller *et al.* 1994). Objective of this study was to investigate winter home range of snow leopards within a portion of the Annapurna Conservation Area, Nepal.

STUDY AREA

The study was conducted in the upper Marsyangdi Valley in the Manang District within the Annapurna Conservation Area, Nepal (28°30' - 28°50' N, 83°50' - 84°55' E). The study area lies in the rain shadow of the Annapurna Mountain Range and has a dry, cold climate. It is above the tree-line, ranging in elevation from 3,600 - 6,000 m with vegetation consisting of grassland interspersed with scrub. A detailed description of the study area is given by Oli (1991).

The snow leopard and red fox (*Vulpes vulpes*) were the only large mammalian predators, and blue sheep (*Pseudois nayaur*) were the only wild ungulates in the area. Small mammals included the Himalayan marmot (*Marmota himalayana*), Royle's pika (*Ochotona roylei*), least weasel (*Mustela nivalis*), stone marten (*Martes foina*) and Sikkim vole (*Alticola sikkimensis*).

METHODS

Trapping of the snow leopards was accomplished by two methods. Leg-snares were placed on trails used by snow leopards with the snare cables tied to heavy rocks placed in a pit and weighted down with more rocks. In addition, a "khor" or traditional cage-trap was constructed whereby two thick rock-walls (ca. 2 × 1.5 × 1.5 m) were fitted with a wooden plank roof weighted down with rocks, and trap doors placed at each end. The khor was baited with a live goat. To reach the goat, a leopard would have to go through a screen made from small twigs which tripped the trap door.

Snow leopards were immobilized with a combination of ketamine hydrochloride and xylazine hydrochloride (6:1) at an average dose of 7.3 mg/kg estimated body weight, administered with a dart gun. Immobilized snow leopards were weighed, measured, and ear-tattooed for identification. Sex and age were determined based on weight, tooth wear and genitalia, and reproductive status of females was based on the size and coloration of nipples and lactation status.

Snow leopards were fitted with a radio-collar equipped with an activity sensitive transmitter (ca. 500 g, Telonics Inc., Mesa, AZ, USA). I tracked snow leopards from the ground with hand-held receiving equipment between the capture date (Table 1) and 30 February 1991. Bearings were taken with a hand-held compass, and snow leopard locations estimated by the standard method of triangulation. Estimated locations and visual observations of collared snow leopards were plotted on a topographic map (1:50,000). Unpredictable signal behavior caused by extreme ruggedness and topographic variation of the study area made it difficult to assess the telemetry accuracy. Minimum convex polygon method (White and Garrot 1990) was used to estimate home range size. Same-day locations were excluded from the analysis.

RESULTS AND DISCUSSION

Capture Success

Leg snares were set for 935 trap-nights between July 1990 and February 1991, and 2 snow leopards were captured. Khors baited with live goats were operated for 50 trap-nights between September 1990 and February 1991, and one leopard was captured. Capture success rate for leg snares and the khor was 0.2% and 2.0%, respectively. No major injuries attributable to trapping were noticed except minor scratches on the trapped legs of snow leopards captured using leg snares; the snow leopard captured using the khor was virtually unharmed. A higher capture success rate and the safety of captured snow leopards suggest that khor may be a superior method of live trapping snow leopards, but construction and operation of khor was much more expensive in terms of time and money. No adverse effects of drugs or handling were observed.

Body measurements of captured snow leopards are presented in Table 1. Judging from the body size and size and coloration of the nipples, both females had given birth previously but were not lactating at the time of capture. No evidence of cubs accompanying the captured females was found.

Home Range and Socialization

Based on the 1-2 months of radio-tracking, home range size of snow leopards in Manang varied between 13.8-22.3 km^2 ($\bar{x} \pm$ S.E. = 19.1 ± 2.6 ; Table 2), although the total surface area may be 25 % larger if the considerable relief of the study area is considered (Jackson and Ahlborn 1989). Based on a 4-year study in Langu Gorge, western Nepal, Jackson and Ahlborn (1989) reported home ranges of 11.7-38.9 km^2, but 4 of 5 radio-collared snow leopards maintained ranges < 23 km^2. Late winter (2.5 months) home range of 1 snow leopard in the Hemis National Park, India was 19.0 km^2 (Chundawat 1990). Schaller *et al.* (1994) reported that 1 radio-collared male used an area of 12 km^2 during 41 days of monitoring during November-December in Mongolia. Estimated home ranges of snow leopards in Manang (Table 1) compare closely to these estimates, suggesting that the cats may cover most of their home range in a relatively short time.

TABLE 1. – Capture dates and physical characteristics of three adult snow leopards captured in Manang, Nepal.

Leopard	Sex	Weight (Kg)	Body length (cm)	Tail length (cm)	Capture date
01*	F	40-45[1]	111	89	30 December 1990
02*	M	47	115	93	23 January 1991
03**	F	39	113	78	1 February 1991

[1] Estimated
* Snare trap
** *Khor* trap

As with the results here, Jackson and Ahlborn (1989) also reported smaller home ranges for males than for females. This observation is inconsistent with the land-tenure system of other similar-sized felids, such as the mountain lion (*Felis concolor* ; Hemker *et al.* 1984, Ross and Jalkotzy 1992, Seidensticker *et al* . 1973). Also, home range sizes reported to date for snow leopards are much smaller than those reported for the mountain lion. I attribute this discrepancy to the difficulty in tracking leopards from the ground in a precipitous habitat where access is only by foot, and to small sample sizes. Because of the ruggedness and limited accessibility of the habitat, tracking snow leopards that may exhibit frequent and long distance movements is often difficult, probably resulting in an underestimation of the size of their home ranges.

Association among the collared snow leopards 01 and 02 was detected on 23 January, 1991, the day snow leopard 02 was captured. Two sets of tracks of similar age on the snow, pugmark measurements, and subsequent radio-tracking confirmed that snow leopards 01 and 02 were together until leopard 02 was trapped. This association coincided with the breeding season and suggests that these leopards were breeding partners. Snow leopards 02 and 03, and 01 and 02 were located within 0.5 km from each other once each. Snow leopards 01 and 03, both adult females, always maintained a distance of ≥ 1 km.

Ranges of the three snow leopards were approximately triangular in shape, centered around a river valley, and overlapped almost entirely. Jackson and Ahlborn (1989) also reported extensive overlap in home ranges both within and between sexes. Home range overlap between leopards 01 and 02, 01 and 03, and 02 and 03 was 10.3, 10.4, and 11.2 km^2 respectively, and an area of 8.1 km^2 was shared among all three. The area shared by all leopards supported a dense population of blue sheep (ca. 12/km^2 ; M. K. Oli, unpubl. data), the main prey of snow leopards in the area (Oli *et al.* 1993), and available habitat was similar to that preferred by snow leopards (Jackson and Ahlborn 1988). This area may, therefore, represent a core use area for the collared leopards, with range overlap occurring in habitats where prey is abundant. Nevertheless, snow leopards remain primarily solitary, except during mating season, with marking behaviors, such as scent sprays and scrapes, playing an important role in avoiding inappropriate encounters with conspecifics (Ahlborn and Jackson 1988).

TABLE 2. – Winter home range sizes, number of locations, and tracking period for 3 adult snow leopards in Manang, Nepal. All leopards were tracked between capture date (Table 1) and 30 February, 1991.

Leopard	Sex	Home range (km^2)	Number of locations
01	F	22.3	15
02	M	13.9	16
03	F	21.1	10
Mean (S.E.)		19.1 (2.6)	13.7 (1.8)

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