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HABITAT ECOLOGY OF HIMALAYAN SEROW (Capricornis sumatraensis ssp. thar) IN ANNAPURNA CONSERVATION AREA OF NEPAL

by Achyut Aryal

Introduction

Himalayan serow *(Capricornis sumatraensis* ssp. *thar)* is a threatened animal, listed by CITES in Appendix I and classed as "Vulnerable" by **IUCN's Red Data Book** (IUCN, 2004). It has been given legal protection in other countries as well (Fox & Johnsingh, 1997; Green, 1987b; Shackleton, 1997; Wollenhaupt *et al*., 1997).

Himalayan serow, locally called "thar" (in the study area), belongs to the family Bovidae and subfamily Caprinae. In appearance, the serow resembles a ghoral. The serow is a solitary animal (Nowak & Paradiso, 1983; Prater, 1993; Schaller, 1977); however, sometimes as many as seven individuals have been seen in a herd (Prater, 1993; Nowak & Paradiso, 1983). It has a large head, thick neck, short limbs, long mule-like ears and a coarse coat of dark hair. It looks like a cross between a cow, a pig, a donkey and a goat. Both sexes are similar in appearance and are of about equal size (Schaller, 1977). An adult male serow measures about 100 to 110 cm at its shoulders and weighs about 91 kg on average in its adulthood. Its head and body length measure 140-180 cm. The horns are 15-25 cm long and 13-15 cm in girth and are present in both sexes. The horns are black, conical,

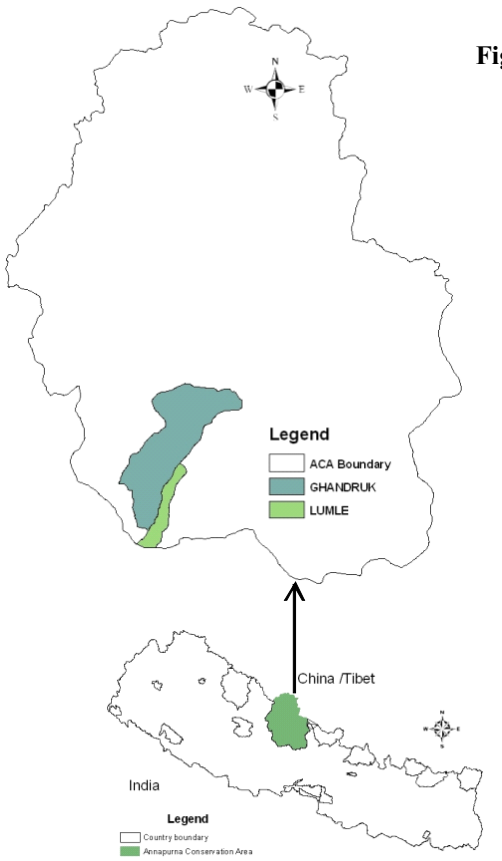

Figure 1: Study area

sharply pointed and directed backwards. The serow has inguinal glands and enlarged pre-orbital glands. It inhabits steep, rugged, inaccessible and densely forested areas of the Himalayas. Serow prefers damp and thickly wooded gorges and occurs at altitudes between 1,500-4,000 m (Prater, 1993; Schaller, 1977).

The serow is oriental in origin (Schaller, 1977). The geographic range is bordered by Jammu and Kashmir (India) in the west and extends to Japan in the far north east (Shackleton & Lovari, 1997; Schaller, 1977). Japanese serow is found in Honshu, Shikoku and Kyushu Islands of Japan (Maruyama *et al.*, 1997). The Formosan serow occurs in 16 provinces in Taiwan (Lue, 1997). The Mainland serow is found in China, Myanmar, Thailand, Malaysia, Sumatra, Cambodia, Laos, Vietnam, Bangladesh, India, Bhutan and Nepal (Nowak & Paradiso, 1983; Prater, 1993; Schaller, 1977; Shackleton & Lovari, 1997).

The main aim of this research was to determine present status of the serow in southern belt of the Annapurna Conservation Area (ACA) of Nepal. This study focused on the habitat preference of serow in Ghandruk and Landruk forest areas of ACA Nepal.

Study area

Annapurna Conservation Area, the first conservation area and the largest protected area in Nepal, has adopted a new approach and concept in protected area management. The ACA covers a landmass of 7,629 km^2, ranging from sub-tropical regions to altitudes of 8,000 m within a short horizontal distance of less than 35 km. The ACA harbors a recorded total of 1,226 species of plants, 38 species of orchids, 9 species of rhododendrons, 101 species of mammals 474 species of birds, 39 species of reptiles and 22 species of amphibians (ACAP, 2002).

The study was carried out in Ghandruk, Landruk and some parts of Lwang Ghallel VDCs of the southern belt of ACA, covering a total area of 206 km^2. Due to the combined effects of climatic and topographic variation, this area comprises a wide range of bio-climatic zones, hosting a rich

biological diversity. The region exhibits vegetation from sub-tropical forest to alpine grassland. Shrestha & Ale (2001) partially listed about 108 species of trees and shrubs from this region. *Rhododendron arboreum* is the most common species; four species of *Rhododendron* have been recorded (Poudel, 2003). This region is home to about 48 mammal species and 210 bird species (Shrestha & Ale, 2001). Out of 5 Caprinae species in the country, 3 are present in this area, i.e., *Hemitragus jemlahicus* (Himalayan tahr), *Nemorhaedus goral* (Goral) and *Capricornis sumatraensis* (Serow). Five species of cat, including clouded leopard and common leopard, are found in this region (Shrestha & Ale, 2001).

Material and methods

A preliminary survey was carried out to locate potential areas for serow before the actual field work started. This was done through questionnaires targeted at local concerned and knowledgeable people such as villagers, herders, local leaders, and ACA staffs. Local people were involved with all the aspects of the project with the belief that they could learn new techniques and share important information with us. The study was carried out in between January- December 2007.

Habitat preference, use, availability

Hall *et al.* (1997) defined habitat use as "the way an animal uses (or 'consumes' in a generic sense) a collection of physical and biological components (i.e., resources) in a habitat." Hall *et al.* (1997) defined habitat availability as the accessibility and procurability of physical and biological components of a habitat by animals. This is in contrast to the abundance of these resources, which refers only to their quantity in the habitat, irrespective of the organisms present (Weins, 1984). Hall *et al*. (1997) defined the terms habitat use and habitat availability to analyze the habitat preferences of serow.

Random sampling was used to collect habitat parameters from the field. When the author encountered signs of serow (e.g., pellets, hair, resting places, footmarks) he was able to lay out plots which were assumed as habitat use (U) plots; other parameters were also taken from the plots. Sample plot sizes for plants were used as suggested by Schemnitz (1980): 10m x 10m for tree layer, 4m x 4m for all woody undergrowth to 3m in height, and 1m x 1m for the herb layer in composite plots. Other parameters noted such as altitude, slopes, canopy cover, ground cover, land features (cave, cliff, rock, etc.) were also recorded in plots. Simultaneously, habitat availability plots were taken in a random direction and random distance (100 to 200m) and other parameters were noted as for the habitat use plots. Any signs of serow found in the field were recorded as the 'habitat use' plot. Altogether, 187 plots were randomly taken from the survey area.

Ivelv's electivity index (I)

Ivelv's electivity index was used to determine the habitat preference of the serow. Ivlev's index varies from -1.0 to +1.0 with positive values indicating preference, negative values avoidance, and 0 values indicating random use. Habitat use (U) and habitat availability (A) were used to analyze the habitat preferences of serow (Hall *et al*., 1997). Following Ivelv's electivity index (I) (hereafter Ivlev's Value (IV)) the following formula was used to calculate the habitat preference of serow:

I or IV= (U%-A%)/U%+A%) (Ivelv, 1964; Krebs, 1989).

Altogether 187 plots (U plot=97; A plot=90) were set up in the survey area. Habitat preferences of the different habitat parameters such as altitude, slope, trees, shrubs, herbs species were analyzed. The plants species which had positive Ivlev's Value (IV) indicated preference, those which had a negative IV were avoided, and those with a 0 IV were used as random use plants. The ANOVA test was used to analyze the significance of preference of different habitat parameters with the null hypothesis: all habitats are used in proportion to their availability. Two data factors were used for ANOVA test, i.e., availability and use.

Importance Value Index (IVI)

The IVI of a tree species was calculated by the addition of relative density, relative frequency and relative dominance (Dinerstein, 1979).

IVI = relative density + relative frequency + relative dominance.

Results and discussion

Habitat Preference (Habitat Use and Habitat Availability)

Altitude preference

Himalayan serow mostly prefers to live at 2,500 to 3,500 m altitude. There was less evidence to demonstrate the occupation of altitudes lower than 2,500 m, which was illustrated by the fact that Ivlev's value was only 0.064, meaning very low preference and near to random use. Altitude preference increased with increases in altitude from 2,500 to 3,500m, and then a sudden decreased preference for altitudes from 3,500 to 4,000m. Altitudes ranging from 2,500 to 4,000m was mostly used for feeding and shelters; the animals preferred higher altitudes as safe places from predators. There was zero Ivlev's value for the 4,000 m altitude, which indicates that serows randomly use this altitude. Serows totally avoided altitudes above 4,000m. There was significant difference in use of different altitudes proportional to available habitat (ANIVA,, $P<0.05$).

Slope preference

Serows generally prefer gentle to steep sloped areas (20% to 40%). With the increase in slope, Ivlev's value also increases from 0.1 to 0.3; in contrast, plains or flat sloped areas (10% to 20%) are avoided by the serow (Ivelv's value < 0.0). Steeply sloped areas are used by the serow as resting places, while gentle sloped areas are used for grazing purposes. Plain or flat sloped areas up to 20% are mostly used by the villagers' livestock and serow are not often found there (although livestock share space with the serow in all elevations as livestock dung, especially sheep and goat pellets, were found in all areas of the serow habitat). There are significant differences in the use of different slope types proportional to availability (ANOVA, $P<0.05$).

Covers

The Serow uses different cover (living and physical) features of the environment to provide a protective "screen" from weather, predation, and human hunting. This sheltering cover provides the serow with a security blanket that makes use of the various cover types in its habitat. Dense forests, rocky areas and cliffs are capable of hiding 90% of the serow from the view of a person from a distance of 200 ft or more. Consequently, the serow mostly prefers dense forest (Ivelv's value (IV) - 0.27), and has less preference for cliffs (IV-0.17), rocky areas (IV-0.19), and caves (IV-0.09). Regions classified as streambeds, with no cover or gullies (IV <0.0) are avoided by serow. These areas don't provide them with cover and make it difficult for them to hide from predators due to the open visibility. There was significant difference in the use of different covers proportional to availability and the use of different cover types by serow (ANOVA, $P<0.05$).

Crown cover

Crown cover is used by the serows for hiding and as thermal covers. A thick crown cover helps them maintain their body temperature. Serows use crown cover to protect themselves from both heat and cold. Moderate crown cover (50%-75%) is preferred by serow (IV-0.19). Preference gradually decreases with the decrease in the percentage of crown cover. Sparse to moderate crown cover are preferred for grazing purposes. There is a significant difference in the use of different crown covers proportional to the available crown cover by the serow (ANOVA, $P<0.05$). There is a positive correlation between crown cover and habitat preference (R^2-0.44), with preference increasing in the presence of sparse cover to dense covers. Sparse crown cover is totally avoided by serow (IV<0.0).

Ground cover

Most of the signs of serow were found in areas with moderate ground cover (50%-75%) where Ivlev's Value (IV) is the highest. This indicates that serow prefers moderate ground cover. Moderate ground cover is preferred for grazing while dense ground covers help to regulate body temperature and provide places to hide from predators. Very sparse ground cover (0-25%) was totally avoided (IV<0). There was significant difference in the use of different crown cover proportional to available ground cover by serow (ANOVA, $P<0.05$).

Tree, shrub & herb preferences

Serow prefers palatable plants and most often these plants have higher nutrient contents than plants which are avoided. This study does not cover the feeding behavior of serow, but gives an idea about preference of vegetation. A total of 23 tree species, 14 shrubs and 32 herbs were recorded in the serow habitat. Table1 lists 11 trees species that serows use for feeding and cover (thermal & hiding) The following species were most preferred by the serow: *Michalia champaca*, (IVI-36, I-0.17), *Rhododendron arborium* (IVI-40; IV 0.11), *Ilex dipyrena* (IVI-33; IV-0.16). *Lindera neesiana (IVI-16, IV-0), Lyonia ovalifolia* (IVI-12, IV-0) and Guheli (IVI-9, IV-0) were moderately important and used randomly by the serow, while other tree species such as *Pinus wallichiana,* Phalat, kaulo, *Cinamomum* spps and *Schefflera impressa* were less preferred or avoided. These tree species are valuable in terms of timber production in the area so there is high pressure from the villagers. Every year they harvest these tree species for construction, furniture, etc. Therefore, this resource competition remains one of the largest challenges to managing these tree species for serow. Conservation incentives and awareness programs are essential to encourage local people to plant such valuable tree species on their private lands as well as on community lands in order to reduce the pressure on serow habitats. There was no significant difference in the use of tree species by the serow and all trees species were used in proportion to their availability (ANOVA, P-0.369).

Table 1: Trees species preference by serow (R^2 = 0.22)

Tree Scientific name	***IVI***	*Ivlev's Value*	***Habitat/tree use***
Michalia champaca	36	0.17	Preference
Rhododendron barbatum	15	0.06	Preference
Rhododendron Compalatum	29.21	0.07	Preference
Rhododendron arboriam	40	0.11	Preference
**Phalat*	9	-0.14	Avoided
Lindera neesiana	16	0	Random
**kaulo*	18	-0.01	Avoided
Ilex dipyrena	33	0.16	Preference
Juniperus sp.	5	0.04	Preference
Picea sp.	14.32	0.06	Preference
Pinus wallichiana	5	-0.03	Avoided
Preroarpua santalinus	11	0.06	Preference
Abies pindrow	8	-0.03	Avoided
Lyonia ovalifolia	12	0	Random
Acer spp	9	0.06	Preference
Schefflera impressa	16	-0.05	Avoided
Cinamomum spps	8.47	-0.2	Avoided
**Guheli*	9	0	Random
Engelhardtia spicata	17	-0.3	Avoided
Lindera neesiana	21	0.02	Preference
Quercus lamellose	16	-0.3	Avoided
Q. semecarpofolia	34	0.09	Preference

(continued on p.17)

(continued from p.16)

Shrubs

A total of 14 shrub species were found in serow habitat, out of which eight shrub species were preferred by serow. Nigalo, *Daphne spp, Mahonia napaulensi, Dryopteris filix-mas, Momordica* sp., *Dryopteris wallichiana,* and *Smilax macrophylla* were the most preferred shrub species in serow habitat (Table 2). All shrub species were used in proportion to their availability (*ANOVA,, P-0.083*). These plants were used by serow for food and also have medicinal value. These plants are non-timber forest products (NTFPs) that the local people use for their subsistence. Nigalo, *Dhaphne* spps. and *Mahonia* spps. are illegally over-exploited in the serow habitat, sometimes with the approval of the local conservation committee. Conservation of these species is the main concern for *in situ* conservation of serow. Maru and *Rosa spps* are totally avoided by serow because these plants have an unpleasant smell, while Dyakar is randomly used by serow.

Table 2: Shrubs species preference by serow (R^2 = 0.022)

Shrubs species	*Ivlev's Index Value*	*Preference*
Dryopteris filix-mas	0.13	Preference
Berberis spp	-0.5	Avoided
Momordica spp	0.3	Preference
**Maru*	-0.12	Avoided
Smilax macrophylla	0	Preference
Berberis aristata	0.09	Preference
**Dyakar*	0	Random
Mahonia napaulensis	-0.12	Avoided
Viburnum	0.01	Preference
Daphne spp	0.1	Preference
Dryopteris wallichiana	-0.12	Avoided
Rubus ellipticus	0.12	Preference
Rosa sericea	0.01	Avoided
**Nigalo*	0.1	Preference

Herbs

A total of 32 herb species were recorded in the serow habitat. The following 19 herbs were preferred by serow: Tilko ghans, bankarelo, *Momordica* spp., *Thalitrium* sp., *Selinum tenuifolium, Hypericum* spp. and *Lichen usnea* were the herb species most preferred by serow. Herb species such as *Leontopodium jacotianum, Anemia, Anaphalis, Adiantum venusium,* and *Centella asiatica* were randomly used for feeding purposes. Eight herb species were totally avoided by serow, including *Gaultheria trichophylla, Chharchakeya, Leycesteria formosa*, etc. (Table3). Intense harvesting of herb species by local people from serow habitat was another problem. Most of the herbs have medicinal value, so the local people – especially the poor – illegally collect herb species for their daily livelihood; the herbs are transported to local trade cities such as Pokhara or given to the village's hidden traders.

Serow avoided some herb species so all herb species weren't used in proportion to their availability.

Table 3: Herb species preference by serow (R^2 = 0.0005)

Herbs Scientific name	*Ivlev's Index Value*	*Herb Use Status*
Pericampylus glaucuss	0.08	Preference
Leontopodium jacotianum	0	Random
**khar*	0.05	Preference
Permilia spps.	0.08	Preference
Thalitrium sp.	0.07	Preference
Gaultheria trichophylla	-0.04	Avoided
Aconitum spps.	-0.09	Avoided
Selinum tenuifolium	0.01	Preference
**Chharchakeya*	-0.07	Avoided
Primula sp.	0.05	Preference
Hypericum spp	0.03	Preference
Elatostema spp	0.02	Preference
Myrica spp	0	Preference
Leycesteria Formosa	-0.03	Avoided
Ludwigia hyssopifolia	-0.06	Avoided
Themeda triandra	-0.5	Avoided
Aconogonum spp	0.08	Preference
Centalla asiatica	0.07	Preference
Fragaria spps.	0.1	Preference
**Tilko ghans*	0.15	Preference
Leucas cephalotes	0.04	Avoided
Anemia	0	Random
Anaphalis	-0.2	Random
Momordica spps	0.02	Preference
**Chiple*	0.01	Preference
**thotne*	-0.09	Avoided
Adiantum venusium	0	Random
Centella asiatica	0	Random
Reinwardtia indica	0	Preference
Potentilla fulgens	0.14	Preference
Rubia cordifolia	0.02	Preference
Lichen usnea	0.06	Preference

Conclusions and recommendations

Himalayan serow *(Capricornis sumatraensis* ssp. *thar)* is a threatened, solitary mammal of Asia. This study has generated a baseline for further research on this species.

The population of serows is only concentrated in the southern part of the ACA region, especially in Ghandruk and Landruk; therefore, the authorities must concentrate on this species for further research and conservation activities. The serow's feeding ecology and co-existing patterns with predators and other ungulates in the area should be priorities for further research.

Generally, governments and researchers focus on wildlife species such as tiger, rhino, bears, snow

leopards, etc, that have high economic and illegal market value. These species have more available funds for their conservation and management through national and international sources compared to the serow. This situation results in a lack of knowledge about the illegal market value of species such as serow, hispid hare, etc. Therefore, concerned agencies and researchers must give equal emphasis to *in situ* conservation of low illegal market value species such as serow, which is a favorite prey species of threatened species like leopards.

The major problems in serow habitats are habitat fragmentation, land use changes, reduction of the serow population, conflicts between serows and predators and villagers, livestock grazing in serow habitat, and poaching. Further research and conservation education are essential to conserve this species.

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NEW SITE REPORTS OF FOUR-HORNED ANTELOPE Tetracerus quadricornis (BLAINVILLE)

by Vinayak K. Patil and Sanjay G. Bhave

The four-horned antelope *Tetracerus quadricornis* (Blainville 1816) – FHA hereinafter – is a threatened species endemic to the Indian subcontinent. It is categorized as "Vulnerable" in IUCN's **Red List** (Mallon, 2008). Its distributional range has considerably shrunk in the last century (Krishna *et al.*, 2009). A recent review by Krishna and co-workers (2009) reports its occurrence in 104 sites in India. Most of the site information in this review was obtained from a mail survey conducted by Rice (1991). A few additional sites are reported here where we have recorded evidence of the animal's presence. These new sites essentially fill a large gap in the distributional range of this species (see Fig. 1 and Table 1). Looking at the gap, it is clear that information is not available from southwestern Maharashtra.

The gap is depicted in the map by a triangle made by the three nearest reporting sites, i.e. Karnala Bird Sanctuary in the north, Osmanabad Forest Division in the east and Dandeli Wildlife Sanctuary in the south (Rice, 1991; also see map in Krishna *et al.*, 2009). This is a triangle with all sides measuring approximately 400 km. It is essential to fill in such a huge gap with reliable records. Due to logistical constraints, we could only explore the