Status and Conservation of Himalayan Serow (*Capricornis sumatraensis. thar*) in Annapurna Conservation Area of Nepal
-A Final Report-

Submitted by:
Achyut Aryal
The Biodiversity Research and Training Forum (BRTF), Nepal
P.O.Box-299, Pokhara, Nepal
Email savefauna@yahoo.com

2008

Status and Conservation of Himalayan Serow (*Capricornis sumatraensis. thar*) in Annapurna Conservation Area of Nepal.

A Report Submitted to:

Rufford Small Grants Foundation, UK

Submitted by

Achyut Aryal
Team Leader
The Biodiversity Research and Training Forum (BRTF), Nepal
P.O.Box-299, Pokhara, Nepal
Email savefauna@yahoo.com/ info@brtf.org.np
Website: www.brtf.org.np

Cover Photo © Achyut Aryal, 2008: Wild Himalayan Serow in landruk forest.

Grant Recipient Details	
Your name	Achyut Aryal
Project title	**Status and Conservation of Himalayan Serow (*Capricornis sumatraensis. thar*) in Annapurna Conservation Area of Nepal**
RSG reference	**10.07.07**
Reporting period	August 2007 to August 2008
Amount of grant	£3170
Your email address	savefauna@yahoo.com
Date of this report	1 September,2008

Acknowledgement

I would like to acknowledge Professor Dr. Marco Festa-Bianchet (Chair, IUCN Caprinae Specialist Group), Professor Dr. Johann G. Goldammer (Director, Global Fire Monitoring Center, UN-ISDR, Germany), Professor Dr. A.K Das (IOF, Tribhuvan University, Nepal), Professor Dr. I.C. Dutta, Professor, Dr. Ilse Storch and Professor Dr. Dr. h. c. Dieter R. Pelz (Faculty of Forest & Environment Science, Albert- Ludwigs University of Freiburg), Mr. Jill Nelson (PTES, UK), Mr. Jose Cole & Ms. Jane Raymond (Rufford Small Grant Programme, UK) and Mr. Madhav Prasad Ghimire (Secretary, Government of Nepal), for their remarkable guidance, creative comments and suggestions in all stages of this project.

I am highly indebted to People's Trust For Endanger Species (PTES, UK) and Rufford Small Grant Foundation, UK for providing funding for this Project.

I wish to extend sincere thanks to whole PTES and Rufford Small Grants Programme UK's family for his encouragement, guidance and suggestions. I would like to acknowledge Lal Prasad Gurung (Project Director, ACAP) for granting me the permission to conduct the project in ACA. It would not have been possible to complete the task without the support of the staff different stakeholders of the project area specially ACAP Unit office, Gandruk office's staffs Shyam Gurung who guided initial to end of the project and others staffs Rajesh Gupta (Sr. Ranger) who provided important information and necessary support to conduct field survey in the area.

Thanks are extended to Anjala Pyakurel for her creative comments and suggestion to complete this project and others persons Mr. Sundar Pr. Sharma (Coordinator, South Asia Wild land Fire Network), Mr. Nawaraj Gautam, Mr. Santosh Aryal, and Mr. Shusant Ghimire, and Kamal bhai for their generous supports.

Abstract

Himalayan Serow *'Capricornis sumatraensis. Thar'* (hereafter Serow) is a threatened, solitary mammal of Asia. The project has able to collect baseline data on this species and able to change local people attitude towards the conservation of Serow in natural habitat. The research explored the population and habitat preference of Serow. The serow population is isolated in a small patched of the southern part of Annapurna Conservation Area (ACA) with a population density of 1.17 individual/km^2 and a population sex ratio of 1:1.6(Male: Female). A strong correlation was found between population (y) and pellets density (x) ($Y=0.011x-0.2619$, R^2-0.97). The altitude preference of the serow depended on disturbance but positive correlation was found with different altitude preference (R^2-0.5212): most preferred altitude was 2500 to 3500 meters (Ivlev's Value (IV)-0.44). The serow prefers gentle to steep slopes with the increasing Ivelv's value by 0.1 to 0.3 but weak correlations between them (R^2-0.16). The serow mostly prefers dense forest (IV- 0.27), with descending order of preference being rocky (IV-0.19), cliff (IV-0.17), and Cave (IV-0.09) with weak correlation (R^2-0.0096). There was significant difference in the use of different habitat parameters such as altitudes (F-0.0001, P<0.001), slopes (F-0.0013, P<0.001) covers (F-0.001, P<0.001), crown covers (F-0.001, P<0.001) and ground covers (F-0.001, P<0.001) proportional to available habitat parameters.

In total 23 tree species, 14 shurbs and 32 herbs were recorded on serow habitat. The serow showed preference for 11 trees species in its habitat which were used for feeding & cover (thermal & hiding) purposes and, of them *Michalia Champaca*, (IVI-36, I-0.17), *Rhododendron arborium* (IVI-40; IV 0.11), *Ilex dipyrena* (IVI-33; IV-0.16) were most important and preferable to the serow. Plants species were used in proportion to their availability {Trees (F-1.428, P-0.369), Shrubs species (F-88.869, P-0.083) and herb species *(F-0.459, P-0.895)}*.

The major problems in the serow habitat were habitat fragmentation & land use change, conflict between predator and villager, livestock grazing and poaching. Conservation education was an effective way to raise awareness of serow conservation among the local people. The project was successful in providing information on the present status of Himalayan Serow in the ACA.

Generally, Government and Researchers are focusing on wildlife like Tiger, Rhino, Bears, Snow leopards, etc, that have high economic and illegal market value. These species are easier to raise funds for from international sources. That's the reason behind lack of research on low illegal market value species like Serow, Hispid hare, etc. Therefore, concerned agencies (Government/NGOs, INGOs, Civil Society) and researchers must give equal emphasis in-situ conservation of low illegal market values species such as serow, which is a prey species for threatened species like leopards.

Key Words: *Fragmentation, Ivelv's Value (IV), Important Value Index (IVI), habitat preference etc.*

Table of Contents

Figures:

Maps

Pictures

Tables

ACRONYMS

ACA: Annapurna Conservation Area

ACAP: Annapurna Conservation Area Project

CAMC: Conservation Area Management Committee

CITES: Convention on International Trade of Endangered Species of Wild
Flora and Fauna

GIS: Geographical Information System

GN: Government of Nepal

GPS: Global Positioning System

Ha: Hectare

HMG/N: His Majesty's Government of Nepal

HSI: Habitat Suitability Index

ICDP: Integrated Conservation and Development Project

IOF: Institute of Forestry

IUCN: (World conservation Union) International Union for Conservation of

IV: Ivelv's Value (Ivelv's electisity Index)

IVI: Importance Value Index

Km^2: Square kilometre

m : meters

Nature and Natural Resources

NTFPs: Non-Timber Forest Products

OIC: Office-in-Charge

pers. comm.: personal communication

UCO: Unite Conservation Office

VDC: Village Development Committee

Technical and Field Report

Introduction

Himalayan Serow *'Capricornis sumatraensis. Thar'* (hereafter Serow) is a threatened animal, listed in Appendix I by CITES and classed as "Vulnerable" by IUCN Red data (IUCN, 2004). It is listed as Endangered by WWF/Nepal and Department of National Park and Wildlife conservation, Nepal (Chapagai, *et. al.* 2002). Owing to its population decline, its hunting has been prohibited throughout Nepal since 1992 (Wegge & Oli, 1997). It has been given a legal protection in other countries as well (Fox & Johnsingh, 1997; Green, 1987b; Shackleton, 1997; Wollenhaupt et al, 1997).

Himalayan Serow (hereafter Serow) is locally called a "thar" in the study area, belonging to the family Bovidae and subfamily Caprinae. In appearance, the serow resembles a goral. Serow is a solitary animal (Nowak & Paradiso, 1983; Prater, 1993; Schaller, 1977), although sometimes as many as seven havebeen seen in a group (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 about equal size (Schaller, 1977). An adult male serow measures about 100 to 110cm at its shoulders and weighs about 91 kg on average in its adulthood. Its head and body length measure 140-180cm. The horns are 15-25 cm long and 13-15 cm in girth and are present in both sexes. The horns are black, conical, 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 Himalaya. Serow prefers damp and thickly wooded gorges and occur between 1500-4000m (Prater, 1993; Schaller, 1977). It is also seen on open cliffs and rocky slopes. Serow feed on grasses, shoots and leaves (Nowak & Paradiso, 1983).

The serow is oriental in origin (Schaller, 1977). The geographic range is bordered by Jammu and Kashmir (India) in the west to the Japan in the far north-east (Shackleton & Lovari, 1997; Schaller, 1977). Japanese serow are 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).

In Nepal, it is distribution in different mountain's protected area but there is no study in this as far, this study has attempted to first study and conservation project which has able to attract view of scientific committee, students and international committee for further work on its conservation biology.

Aim and Objectives

The main aim of the project was to determine present status and raise conservation education in local level.

Specific objectives:
1. To determine the population Status of Serow in study area.
2. To quantify habitat Preference and distribution pattern of Himalayan Serow (Habitat Suitability Analysis) using GIS technique.
3. To assess past and present the poaching activities and trade pattern of Serow in study area.
4. To map out distribution and potential poaching area in ACA.
5. To Know the perception of schools' student and local people towards the conservation of serow
6. To raise conservation awareness among the local as well as national people.
7. To analysis the threats on Himalayan Serow population and its habitats through the participatory approached and prepared participatory conservation action plan.

Study area

Annapurna Conservation Area and Study area

Annapurna Conservation Area (ACA), the first conservation area and the largest protected area in Nepal, has adopted a new approach and concept in protected area management. It is managed by National Trust For Nature Conservation (NTNC) (Previously the King Mahendra Trust For Nature Conservation (KMTNC)) as the Annapurna Conservation Area Project (ACAP). The underlying principle of the project is to strengthen the linkages between ethics and environment taking local communities as both principal actors and beneficiaries of the conservation undertakings. Unlike the conventional protected area management approach where people are viewed as the undermining agents of the environmental degradation, ACAP strongly considers local people as the masters of environment conservation. NTNC has been successful in integrated conservation and development programmes in ACAP. This made ACAP the most successful integrated Conservation and Development Project (ICDP) in the world (ACAP, 2002). Annapurna Conservation Area is a land of extremes located in the north central part of Nepal. The ACA covers a landmass $7,629km^2$ with altitudes ranging from Sub-tropical region to 8,000m within a short horizontal distance of less than 35km. The southern sector of ACA is humid and warm with a subtropical climate, while the northern sector is cold and semi-desert. The ACA has an extremely diverse floral and faunal kingdom in a variety of interrelated ecosystems from subtropical to alpine grass lands exist in the ACA. The ACA harbors a recorded total of 1226 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. More than 10 ethnic groups inhabit in region. Some of the ethnic groups are Gurung, Thakali, Manangi, Bhotia, Tibetan, Magar, Tamang, Brahmin, Chhetri and lower cast (Kami, Damai, and Sarki). (ACAP, 2002).

The NTNC established its first field office in Ghandruk in December 1986 to run ACAP's pilot phase which covered only the Ghandruk Village Development Committee (VDC) an area of about 290 Sq. km, After successful indicators in Ghandruk, ACAP began Stage-1 expansion in 1990 to cover 19 VDCs in the southern Annapurna region covering approximately a total of 1,748 sq. km, In 1992, The HMG/N opened Upper Mustang to foreign tourists (it was previously a restricted zone) and in July HMG/Nepal assigned the entire resource conservation responsibility of the area to the NTNC for 10 years to 2002. In

2002, HMG/Nepal extended the arrangement for a further 8 years to 2010. The project now covers 55 VDCs with 55 CAMCs (Conservation Area Management Committee) in 5 districts of Nepal – Kaski, Lamjung, Mygadi, Mustang and Manang. The CAMC is the main body of ACAP through which it implements all programmes & provides support for biodiversity conservation through people participation.

The study was carried out in the Ghandruk, Landruk and some part of Lwang Ghallel VDCs of Southern Belt of ACA. Total study area covered 206 Km2 (Map.1). Population survey and habitat survey was carried out in 56.6 Km2 (Fig.1). Due to combined effect of climatic and topographic variation, this area comprises wide range of bio-climatic zones hosting a rich biological diversity. This region exhibits vegetation from sub-tropical forest to alpine grassland. Shrestha & Ale

Figure 1: Land use pattern of survey area
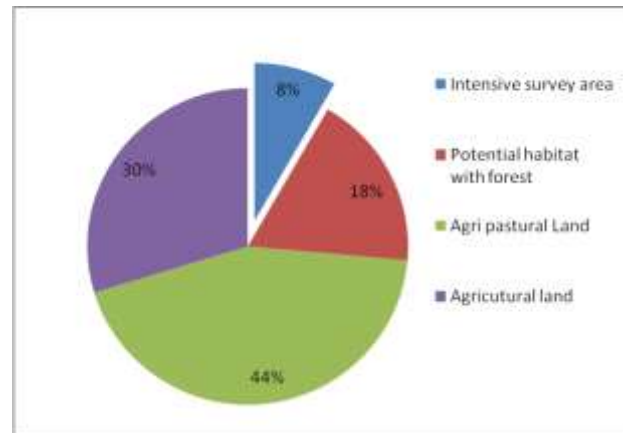
(2001) partially listed about 108 species of trees and shrubs from this region. *Rhododendron arboreum* is the most common species in this region. Four species of *Rhododendron* has been recorded from this region (Poudel, 2003). Shrestha & Ale (2001) has identified the following forest types in this region:

1. *Alnus* forest
2. Broad-leaved forest
3. Conifer forest
4. *Daphniphyllum* forest
5. *Quercus lamellose* forest
6. *Rhododendron* forest
7. Riverine forest

This region is home to about 48 mammal species and 210 bird species (Shrestha & Ale, 2001). Out of five Caprinae species of the country, 3 are present in this area. They are 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. Important bird species include Turdoides *nipalensis* (spinybabbler, the endemic bird of the country)*, Lophophorous impejanus* (danphe)*,* kingfishers, eagles and

vultures, etc. Sixteen species of amphibians, 8 lizard species and 19 snake species have been reported from this region (Shrestha & Ale, 2001).

Protected Areas of Nepal

☐ Study

◯ Annapurna Conservation Area
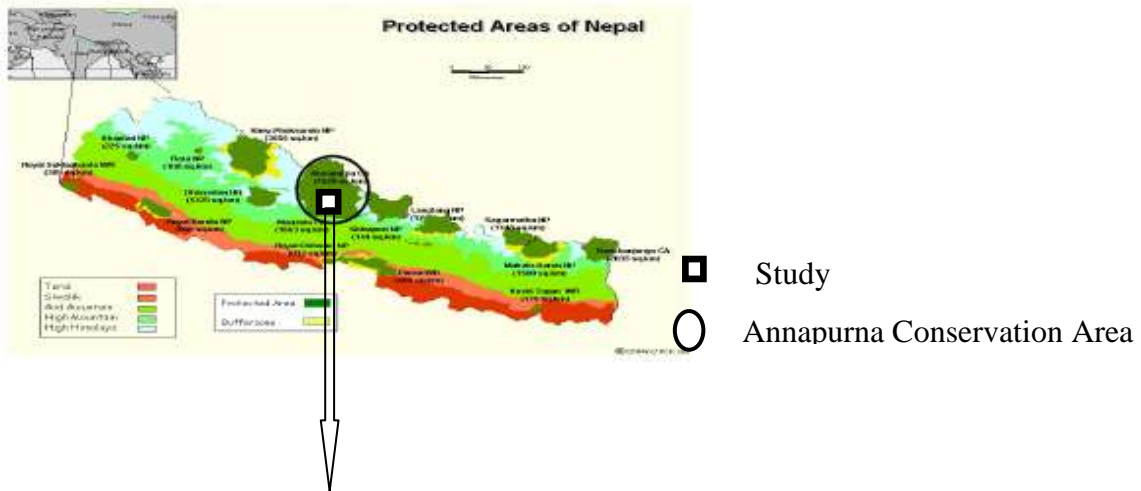
Himalayan Serow Potential Habitat/Study Area

Kilometers
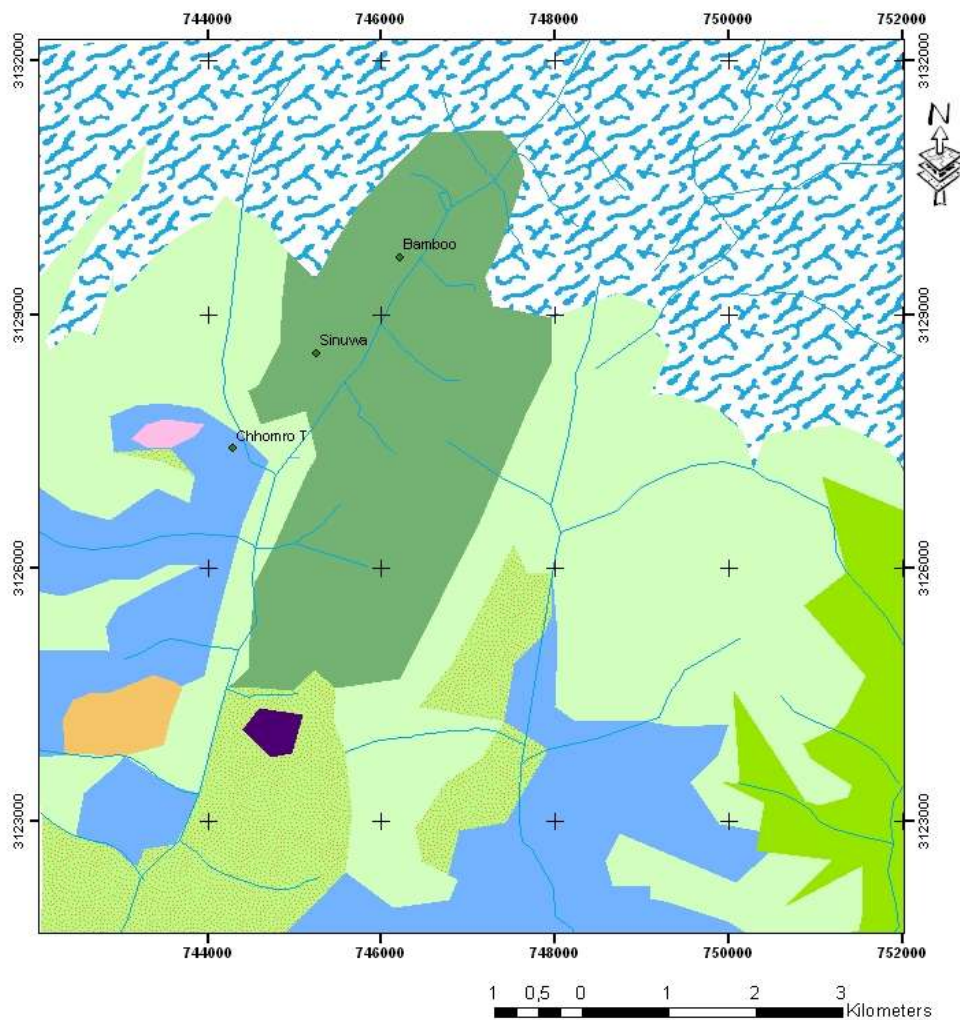
Legend

- River
- Agriculture land
- Intensive Agricutlure land
- Agripasture land
- Chomrong village
- Forest
- Gandruk village
- Landruk village
- Snow & rock area
- Serow Habitat

Produce by: Achyut Aryal, 2007

Methods

Material and Methods

The preliminary survey was carried out to find out potential areas for serow before the actual field work started. This was done by questionnaires targeted at local concerned and knowledgeable people: villagers, herders, local leaders, Annapurna conservation area staff. Local people were involved with all the aspects of the project on the assumption that they could learn new techniques and share important information with us. The study was carried out in the period January- December 2007.

Silent Drive Count Methods for Serow Population Count

(After Green, 1985; Sathyakumar 1994), Green (1985) was the first to use this density estimation technique for Mammals such as the serow, followed by Kattel (1992); Sathyakumar (1994) Vinod & Sathyakumar (1999) and Aryal, (2005), Aryal, (2006). The Silent Drive Count is similar to the block drive census method. The study area of potential serow habitat was divided into small blocks or patches using features such as ridges, streams and foot paths as boundaries. A base line was identified and 8 men were spaced at intervals of 60 m. All these men had some knowledge of the block or patch in which the drive was to be conducted and their line of travel. The men were instructed to scramble quietly through the patch and record ungulates sighted. I and my two research assistants stayed at vantage points, strategically above the forest level to spot and record serow. Data on time, species, number and location, with reference to the line of travel and direction of movement of the serow were recorded. Drives were conducted in early mornings and late afternoons. Duplicate records arising from the same animal being sighted in adjacent blocks or patches were minimized by conducting drives in a direction that flushed the serow outside the study area rather than towards adjacent blocks or patches. Numbers of Serow were counted in two blocks of study area. Similarly pellets were counted in serow habitat in transect (200m*400m). In each transect line me with 2 others research assistants were walked from lower to higher altitude for searching serow's pellets. Old and new pellets of serow were counted and pellet density was calculated with dividing total pellets count by area. The two sets of data (pellets count and population count) were correlated and regression equation was created to predict the serow population through pellet distribution. Such an equation is appropriate for this ungulate which uses their latrine in the old latrine sites. Telescope and

binoculars were used to count from vantage points.

Poaching activities (Past and Present)

Our main field assistant/guide was previously a hunter so the project was able to use his knowledge to understand past and present poaching activities. Besides this direct observation, questionnaire surveys were used with other key people in the study area. Formal and informal interviews were used to find out about hunting practices, poaching areas, poaching intensity, wildlife knowledge, hunting equipment and its threats.

Habitat Preference (Habitat 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 teal 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, define habitat use and habitat availability, terms used to analyse the habitat preference of serow.

Random sampling was used to collect habitat parameter from the field. When I encountered serow signs (pellets, hair, resting places, footmarks) I was able to layout plots which were assumed as *habitat use* (U) plots and other parameters were taken from the plots too. Sample plot sizes for plant were used, as suggested by Schemnitz, D.S, (1980): 10m* 10m for tree layer, 4m*4m for all woody undergrowth to 3m in height, and 1m*1m (suggested by Schemnitz, D.S, 1980) for the herb layer in composite plot. Other parameters noted were altitude, slopes, canopy cover, ground cover, land features (cave, cliff, rock, etc) and 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. If I found any signs of serow, I recorded this in the habitat use plot.

Ivelv's electivity index (I)

Ivelv's electivity index was use to find out 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 use to analysis habitat preference of serow (Hall et.al 1997). Following Ivelv's electivity index (I) {hereafter Ivlev's Value (IV)} formula was to calculated of habitat preference of Serow

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

All together 187 (U plot- 90 A plots 97) plots were taken from the survey area. Habitat preference on the different habitat parameter such as altitude, slope, trees, shrubs, herbs species were analyzed. The plants species which has positive Ivlev's Value (IV) indicated as preference, which show negetive IV used as avoided and finaly which plant showed the zero IV used as random use plants. One way ANOVA test was used to testing significant of preference of different habitat parameters with the null hypothesis: all habitats are used in proportion to their availability.

Importance Value Index (IVI)
IVI of a tree species was calculated by the summation of relative density, relative frequency and relative dominance (Dinerstein, 1979).

$$IVI = relative\ density + relative\ frequency + relative\ dominance.$$

Habitat Suitability Index
GPS Points, Topo maps and mean Ivelv's value of different block of the study area were used to produce habitat suitability index map of survey area for Serows' population. The proximity to cover, food, water, and suitable vegetation had been taken as positive factors, proximity to human activities, livestock grazing, tourist roads were considered as negative factors. A Topo map of the area was digitized and GPS points of the different block of the area were inter through the Geoprocessing method of Arc View 9.1 Software.

Habitat Suitability Index (HSI) map was prepared on the basis of Ivlev's values of different block of study area and Arc View 9.1 GIS software were used to interpolate it with the ground situation. Study area was divided into the eleven blocks on the basis of natural boundary and disturbance by human. Each block HSI was calculated and overlapping each block are in digitized map of the study area by Geo-processing tool of Arc view software. Each site Ivlev's mean value (I) was taken to calculate HSI.

HSI: Mean I value of altitude + Mean value of Slope+ Mean I Value of Tree, Shrubs, ____

herbs, + Mean I Value of Ground cover, Crown cover

N (total number of parameters)

i.e. HSI: $\sum \underline{X_i\ldots\ldots X_n}$

N

Where $X_i \ldots X_n$ – mean Ivlev's Value of Altitude (i), vegetation, Slope, cover (n)

N – Total types of habitats parameters

HSI has divided as follows

High (0.75-1.00),

Medium (0.75-0.50),

Low (0.50-0.25) and

Unsuitable (0.25-0.00).

Distribution and Poaching and Distribution Areas

Distribution pattern was identified on the basis of direct observation, presence and absence survey (pellets and tracks or foot print observation) and from interview of local herders and other knowledgeable person (key informants). People participatory map was prepared through the local people involvement. Field visit was done to find out the potential habitat, transect line was drawn and move to those transect line for searching their dung, or any symptom. Direct observation has done to confirmation of transect line for presence or absence of Serow's sign. Potential poaching area was find out through the interview with local people and presence of snare in it habitats. GPS points were taken in potential poaching area, distribution area and different fields' points were plotted in digitizing Topo-map of study area. Poaching and distribution area was delineated by using GIS software Arc View 9.1 version.

Participatory Threats Analysis

The participatory threats and impact were mapped through the method developed by *Trevel et.al*. 2004. The method was followed a five step process (workshop): each participant lists the human activities that were the most impact to Serow and natural resources in their region (direct threats) and the role that users, managers, and policy-makers play to promote or facilitate these activities (indirect threats); all participants voted to rank the worst direct threats /impact and to map the locations of these threats/impact at their site. The output maps will amenable to use in GIS analysis (Trevel et.al. 2004):

Results and Discussion

Population Status of Serow

Table 1: Population Count 2007 (1.17 individual/Km^2, Survey area- 17 Km^2)

Block	Male	Female	Juveniles	Total
1st block	2	3		5
6th block	3	6	2	11
3rd block	2	2		4

Population of Serow was concentrated in area surrounding the bamboo; there was less influence of human population. Population survey was carried out in all potential area of Landruk and Ghandruk region on the basis of pellet distribution, though we found population in only three block of survey area (17Km^2). Total 20 serow population were counted through the intensive population survey, which consisted of 7 male, 11 female and 2 juveniles with the population ratio of 1:1.6 (Table 1). Green (1987) recorded 1.6 Serow per sq. km was recorded within suitable habitat in Kedarnath Sanctuary in India. Green (1987b) has reported a total population of 50-100, Serows occurring in Bangladesh in isolated and scattered units. Present study showed that population density (1.17individual/km2) is slightly small then to green's 1987 study of India.

Decline of Serow in study area proceeded at a very rapid pace although ACAP is raising conservation education in local level. On the basis of local elder people's opinion, there was time they could hunt Serow in 500m far from the Landruk village. But at present, it is very difficult to see Serow as well as other wildlife in their forest; it may due to over hunting, habitat destruction by human and livestock. Habitat fragmentation in Serow's forest is another threat to population decline. Main corridor of Serow metapopulation of Landruk and Ghandruk (Tadapani forest) has fragmented by village and agriculture land therefore, population of present survey area has isolated.

Fecal dropping behavior of Serow found unique, it dropped pellets/fecal in old pellets dropping site, so that it is difficult to use direct methods like pellet count methods in transect line for population estimate. The research tried to develop regression model to predict population through the pellet density so that both pellets and population count survey were carried out in the three blocks of study area. On the basis of this, I developed regression equation $Y = 0.011x-0.2619$ (Y-population density, X-Pellet density) (Fig. 2). The result showed that there is high positive correlation (R^2 -0.97) with population density and pellet density. This equation can be used in future for direct monitoring of Himalayan Serow in the area through the pellet survey.
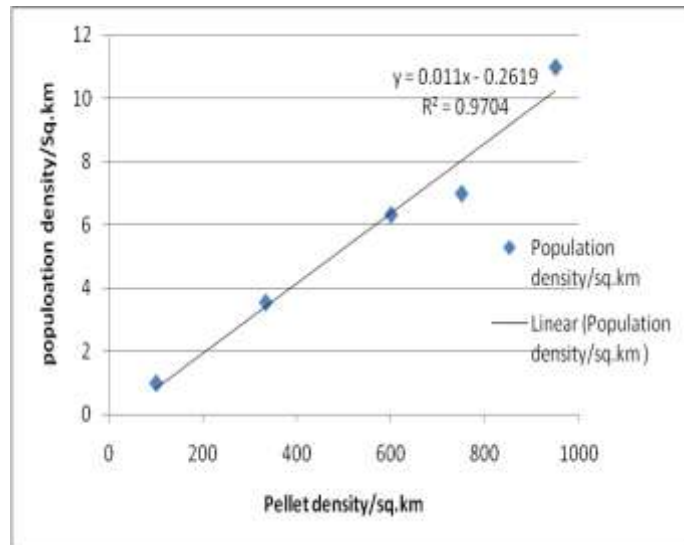
Figure 2: Correlation between pellets density and population density of Serow

Habitat Preference (Habitat Use and Habitat Availability)

Serow Habitat Preference

It was base of habitat use and habitat availability on survey area. Different habitat parameters were taken to determine habitat preference of Serow. Mahato 2003 has studied on this species under the title of habitat preference; he used habitat use parameter but not habitat availability. Mahato's (2003) study had only given idea about habitat use of Serow although he used the term of habitat preference of Serow instead of habitat use. Whereas, this present study has used Ivelv's electivity index on the basis of habitat use and habitat availability parameters to determine habitat preference, random use or avoidance with limited different habitat parameters

Altitude Preference

Himalayan Serow most prefers to live in 2500 to 3500 meters altitude. There was low evidence to use altitude lower than 2500meter which showed that ivlev's value was only 0.064 that mean very low preference i.e. near to random use. Altitude preference has been increased with increasing of altitude from 2500 to 3500m, and then suddenly decrease preference of altitude from 3500 to 4000m (fig.3). Altitude 2500 to 4000m was mostly used for feeding and shelters; and they used high altitude to escape from predators. There was zero Ivlev's value for the
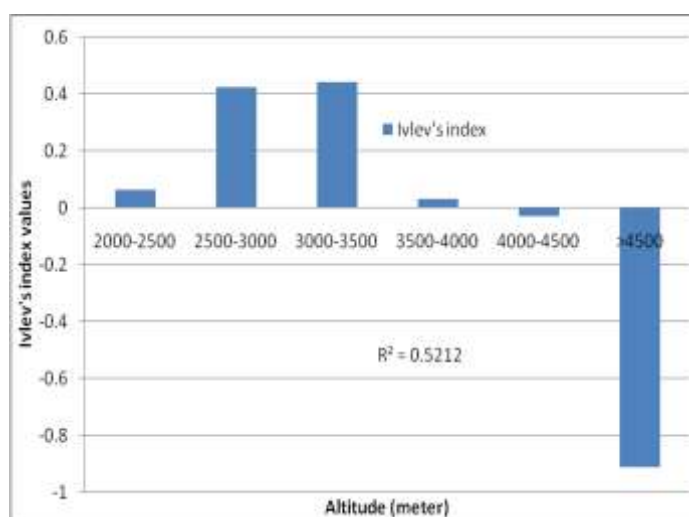
Figure 3: Altitude preference by Himalayan Serow (n-187)

4000 m altitude so Serow uses randomly this altitude. Above the 4000m altitude, Serow totally avoids to use. There was significant different in use of different altitude proportional to available (F-0.0001, P<0.001) but not strong correlation with altitude preference by Serow (R^2-0.5212).

Slope Preference

Serow mostly prefers gentle to steep slope area (20% to 40%). Fig.4 showed the increasing the slope, Ivlev's values was also increasing from 0.1 to 0.3, while 10% to 20% slopes were avoided by serow (Ivelv's value < 0.0). Steep slopes areas are used by Serow as resting place while gentle slope areas are used for grazing proposed. Plain or flat sloppy area up to 20% are mostly used by livestock of the villagers so that Serow don't prefer to interact with livestock, although livestock dung specially sheep/goat's pellets were found in all slope
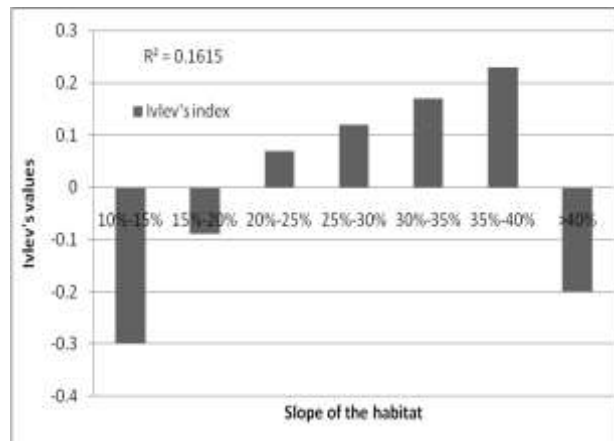
Figure 4: Slope preference by serow (n-187)

area of Serow habitat. There was significant different in use of different slope proportional to available (F-0.0013, P<0.001) and there was weak correlation between slope preference by Serow but not strong relation (R^2-0.16).

Covers

Serow is using different cover (living and physical, fig.5) feature of environment or ecosystem that provides a screen or protective security envelope from weather, predation, and man himself as predator. Hiding cover provides the Serow 'security blanket' that makes use of different possible cover types in its habitat. Dense forests, rocky area and cliff were capable of hiding 90% of Serow from the view of a person at 200ft or less so Serow mostly prefer dense forest (Ivelv's value (IV)- 0.27), gradually they prefer cliff (IV-0.17), rocky (IV-0.19),

Figure 5: Cover preference by serow (n-187)

and cave (IV-0.09). Streambed , no cover and gully (IV <0.0) has avoided by Serow. Mostly covered is used by serow which provides long site distance which make difficulty hide from predators. There was significant different in use of different cover proportional to available

and equally use different cover type by Serow (F-0.001, P<0.001). There was weak correlation between the preferences of different cover type by Serow (R^2-0.028).

Crown Cover

Crown cover is used by Serow as hiding and thermal covers. Major role of crown cover on

Serow is maintaining body temperature within narrow tolerable limit. Crown cover has been used as protection from heat or cold by Serow. Moderate crown cover (50%-75%) mostly preferred by Serow (IV-0.19) as thermal cover, then gradually decrease preference of crown cover with the decreasing of crown cover percentage (fig.6). Sparse to moderate crown cover were used to grazing purposed. There was significant
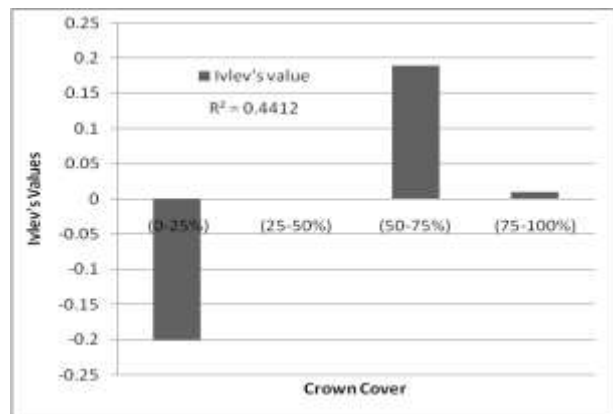
Figure 6: Crown cover preference by serow (n-187)

different in use of different crown cover proportional to available crown cover by Serow (F-0.001, P<0.001). There was positive correlation with crown cover (R2-0.44) that mean preference of crown cover increasing with the increase of rate or presence of crown cover from sparse cover to dense covers. Sparse crown cover was totally avoided by serow (IV<0.0).

Ground Cover

Most of the Serow signs were found in the Moderate cover (50%-75%), Ivlev's Value (IV) is

maximum in moderate ground cover (fig.7) therefore moderate ground cover is mostly prefer by Serow and such cover are used for grazing while dense ground cover are used as thermal and hiding cover. Very sparse ground cover (0-25%) was not highly preferred by the Serow such cover was avoided (IV<0). There was significant different in use of different grown cover

Figure 7: Ground cover preference by serow (n-187)

proportional to available ground cover by Serow (F-0.001, P<0.001). There was very weak correlation with ground cover (R^2-0.0064).

Tree, Shrub & Herb Preference

Serow prefer palatable plants and most often these plants have higher nutritive contents then plants that are avoided. The tree which has positive Ivlev's Value (IV) indicated as preference, negetive IV indicated avoided and zero IV indicated as random use of plants. This study dont say the feeding behavior of serow but it gives idea about preference of vegetation. Total 23 Tree species, 14 shurb and 32 herbs were recorded on serow habitat. Table 2. Showed that serow prefered 11 trees species in there habitat which were use for feeding & covers (thermal & hiding) purposed and out of them *Michalia Champaca*, (IVI-36, I-0.17), *Rhododendron arborium* (IVI-40; IV 0.11), *Ilex dipyrena* (IVI-33; IV-0.16), were most important and most preference species by the Serow. *Lindera neesiana (IVI-16, IV-0), Lyonia ovalifolia* (IVI-12, IV-0), Guheli (IVI-9, IV-0), were moderately important and random use by Serow while others *Pinus wallichiana,* Phalat, kaulo, *Cinamomum spps* and *Schefflera impressa* were less important and avoided trees species by the serow (table.2). These tree species are most valuble timber production species of the area so there is high pressure of the villager, every year they are harvesting such tree for their infrastructure development specieally schools building, and private house construction. Therefore, it is the bigest chanllenges for manage these tree species for Serow. There should have incentive and conservation education programme through which we should encouarge local people to plant such valuable tree species in their private land as well as in community land so that we can reduce the timber pressure on serow habitats. The Serow has avoided using of some the trees species. There was not significant different in use of trees species by the Serow and all trees species were used in proportion to their availability (F-1.428, P-0.369). Relation among the tree species in Serow habitat hasn't related among them in terms of use of trees species (R^2-0.022).

Table 2: 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 barSerow um	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

Local name

Shrubs

Total 14 shrubs species were found in Serow habitat. Eight shrubs species were preference by the serow. Nigalo, *Daphne spp, Mahonia napaulensi, Dryopteris filix-mas, Momordica sp, Dryopteris wallichiana, Smilax macrophylla* were most preferable shrubs species of Serow habitat (table 3).

The serow has avoided to use of some the Shrubs species and there wasnot significant different in use of shrubs by the Serow and all shrubs species were used in proportion to their availability (*F-88.869, P-0.083*). Relation among the shrubs species in Serow habitat hasn't related among them in terms of use of shrubs species (R^2-0.022).

These plants were use by Serow for feeding purposed as well as these plants have medicinal value. Local people were using such plants as Non-Timber Forest Products (NTFPs) for their subsistence. Nigalo, *Dhaphne spps, Mahonia spps* are overexploitation from Serow habitat. It is almost illegally and sometime with the approval of local conservation committee. Conservation of these species is main concern for in-situ conservation of Serow. Maru, *Rosa spps* were totally avoided by serow because these plants have unpleasant smells while Dyakar was randomly use by the Serow.

Table 3: Shrubs species preference by Serow (R² = 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

*Local Name

Herbs

Total 32 herbs species were recorded in the Serow habitat out of them 19 herbs species were mostly prefer by serow. **Tilko ghans, bankarelo,** *Momordica spp***,** *Thalitrium sp.,* **Selinum tenuifolium, Hypericum spp,** *Lichen usnea* were most preferable herb species by serow. Five herbs species such as *Leontopodium jacotianum,* **Anemia, Anaphalis,** *Adiantum venusium, Centella asiatica* were randomly use for feeding purposed. Eight herbs species were totally avoided by serow; they were **Gaultheria trichophylla, Chharchakeya, Leycesteria Formosa etc (table4).** Over harvesting of herb species in Serow habitat was others problems. Most of the herbs have medicinal value, so local people specially poor people collect illegally herbs species for their live hood and the collected herbs transported to local trader in Pokhara city or village's hidden traders.

The Serow has avoided using of some the herbs species but there were not significant different in use of herb species by the Serow *(F-0.459, P-0.895)* so all herbs species weren't used in proportion to their availability. Relation among the herbs species there were not correlation (*R²-0.0005*).

Table 4: Herbs 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

*Local Name

Picture 1: Researcher showing herb Momordica spps

Picture 2: Tilko ghans (Herb): Most preferable Herb by Serow

Habitat Suitability Index (HSI)

Over all Habitat Suitability Index (HIS) has prepared on the basis of mean value of ivlev's index. HSI has been into divided high (0.75-1.00), medium (0.75-0.50), low (0.50-0.25) and unsuitable (0.25-0.00) (fig.8). Area near the village is unsuitable for Serow because of high influence of villager's daily activities for fodder, fuel wood and movement for livestock grazing. Block no. 1, 11 & 5 were unsuitable which HIS value were 0.12, 0.14 & 0.17 respectively. Block no. 2, 4 and 10 have low suitability (0.25-0.50) for Serow population, the area had major problem due to influence by human activities basically for timber as livestock grazing while block 3 and block 8 were moderately prefer

Figure 8: Habitat Suitability Index of Himalayan Serow in Survey Area

and suitable respectively for Serow where there were less human activities. Only the Bamboo, Himalayan area had highest values of HSI that mean Block 9, 7 and 6 were highly suitable for Serow which have good food, cover, water resources and had less human influence but poacher mostly use these site for illegal hunting of Serow & other ungulate. Block no. 7 had highest value of HSI (0.98) which area had 85% area with wilderness, most
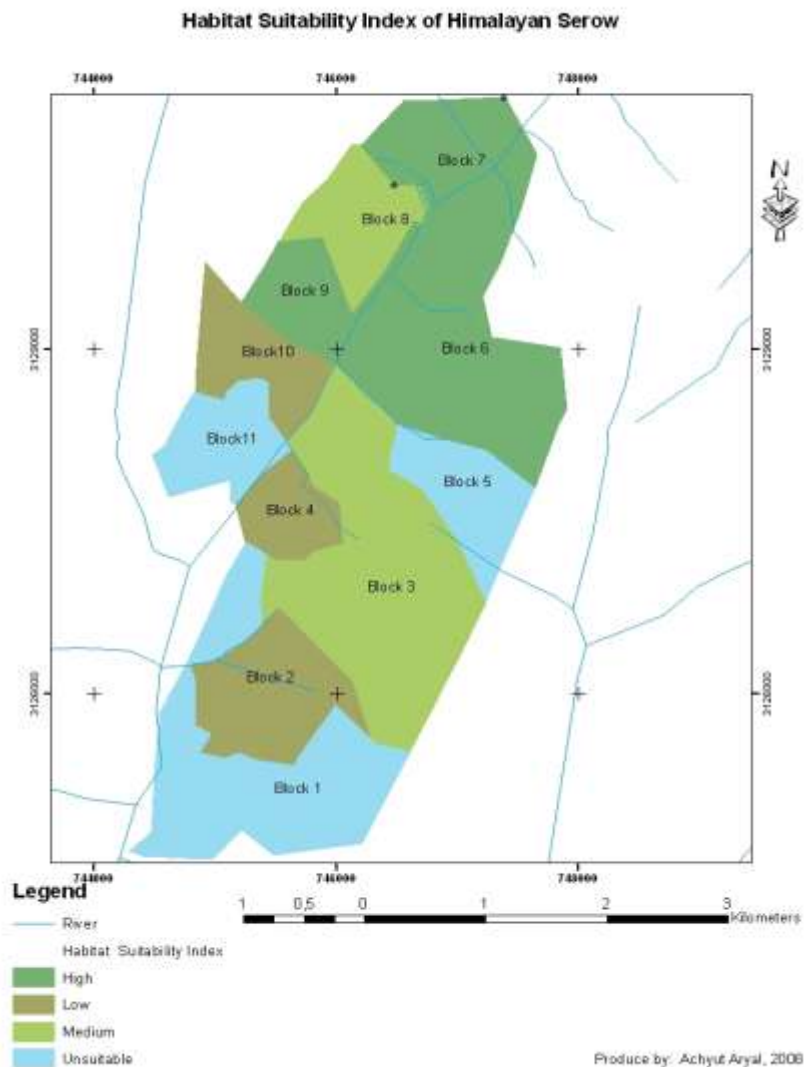
of the Serow and ungulates population can be found in these areas. This HSI can be used by concern authorities to monitor habitat of serow in future.

Attitude and Perception of Local People

Himalayan Serow population is concentrated in Sourthern belt of ACA. Landruk and Gandruk VDCs are main important area for the Serow population. Local people strongly believed that population of Serow have been declining from their forest. The majority of people (92%) expressed positive attitudes toward Serow.

About 67 % of local people said that the population of Serow is decline high rate.

According to herders and other local people, main cause of population declining is poaching; every year large number of snare is collecting from study site. Last year, 97 snares were collected by patrolling team so it seems that there is high rate of poaching activities. Many respondents blamed poaching, killing by predators, human and livestock disturbance in its habitat as the main cause of population decline. Schools student emphasis to launch conservation awareness camp to focus to herder and uneducated people of village.   All the schools students were not known its legal status and only 14% of respondents know its legal status. Villagers were agreeing that poaching activities less in this year as compare to past year. Therefore, there was urgent need to more conservation awareness activities others schools of the southern belt of ACAP

Serow Distribution and Poaching Areas

Serow population has distributed in southern part of ACA region and some isolated population may have concentrated in Manang district of Nepal. Lower belt of ACA, it has distributed in Ghandruk, Landruk and Lawang Ghallel VDCs. In Ghandruk region it has distributed from Chhomrong to Himalayan region and Landruk region has covered high number population which represented whole ACA region's Serow population. In Landruk area, it has distributed in Gau Danda forest, Saine Danda Forest, Pacho Danda, Sasaigo Danada, Pu Danda forest, Naya Kharka Danda area, Parse Danda.

Main poaching areas in Landruk forest are Pacho Danda, Pu Danad forest and Naya Kharka Danda, where local people believe that there is high population concentrated not only Serow

but also other ungulates. CAMC patrolling team regularly found many snares, traps in these areas as compare to other side.

Conservation Status of Serow

Although there is no specific programme in ACAP to conserve serow species in their natural habitat, ACAP has established a Conservation Area Management committee in Landruk and Ghandruk area for conservation of natural resources. CAMC is directly responsible for monitoring the wildlife of their area, although they have no technical manpower. CAMC is patrolling in their forest regularly. Patrolling activities are facilitated by ACAP authorities; they provide some annual expenses to CAMC. Ghadruk and Landruk areas are populated by the Gurung people, most of whomare Buddhists. We should take this as a pin point to conservation of not only Serow but also other wildlife of the area. Poaching and hunting activities are another threat in the area which is led by local or external people, specially porters. Without the support or involvement of local people, external people cannot poach the area so awareness rising among local people is necessary as well as identifying alternative income generating as poverty is the main reason why local people hunt wildlife for their subsistence. But some higher economic status people also hunt serow as a form of recreation.

Past and Present Poaching Strategy

There are no different techniques to kill serow as in Manang and Mustang district where they used to poaching for Musk deer (Aryal, 2005, Aryal, 2006). Hunters use a variety of techniques to kill Serow, which include snaring and shooting, the latter sometimes aided by dogs. In the past hunters usually used guns and dogs but now due to security situation in the country shooting is replaces by snaring.

Present Hunting Technique

There are a few well established methods of hunting and killing Serow by poachers. The most commonly practice method is snaring and trapping. Serow usually follows a fixed trail (e.g., defecating place or grazing ground). Such trail is always well marked in the mountain spur. The poachers are aware of this habit and construct fence lines usually along a mountain spur, encircling a large habitat of Serow, leaving gaps in frequently used paths. Occasionally, the

snare line runs from the top of the mountain to the river valley with more than 50 individual traps. For setting the snare, a small hole measuring about 20 to 25cm and 10cm deep is dug and two small pencil-like pegs with inner side made flat are fixed about 15cm apart inside the hole. After this, a stick of about one inch is bent and strongly fixed with both ends making an arch over it for fixing a trigger. The trigger is pulled further by the pressure of a bent over pole. A small horizontal stick with one side is fixed in the pegs. Just above it a wooden platform is built and a wire snare is set with one end attached to the bent over pole. When Serow treads on the hidden platform, the horizontal stick falls down by the weight of the Serow, the trigger is released with force and as a result the pole straightens, the noose is pulled tight around the animal's leg and the creature is jerked in the air.

Past Techniques

In past, poachers were used to baying by hunting dogs. These dogs are trained to track the Serow. When the dogs locate the Serow, they start chasing without overtaking it till the animal becomes totally exhausted. The dog barks aloud to announce baying of the victim to its master. The poacher arrives at the spot quickly to kill the Serow. Another method is killing the Serow using poison. Serow hunters apply the local poison (*Skimmia laureola*) on the leaves of shrub and bait in areas frequented by Serow. Another technique uses a pointed bamboo arrow or splinter dipped in poison fixed downhill across a regularly used path in a mountain ridge at the level of belly height. When the Serow is disturbed on one side of the ridge, it flees towards the other side by leaps and bounds. At the same time, the poison splinters may inflict a wound in the abdominal region and kill the animal.

Another technique was to shoot Serow. In the past this was the main method of killing Serow but now due to the security situation in the country, all private guns have been impounded in the District Administration Office, Kaski. So shooting was replaced by snaring.

Trade Pattern and Use

It was a very difficult task to identify the trade pattern of Serow in study area. During the study periods many snares and signs of poaching of Serow were found in the study area

which shows that there is also trade in Serow. The trade is impossible without involvement of local people (who provide information about patrolling and do not necessarily set snares/kill Serow directly, only provide information to poachers so as to remain safe from the CAMCs and other authorities), and it is very difficult to discover who is involved. Generally poachers come from Gorkha, Dhading, Lamjung and Tanahaun districts same as manang. According to local people and former hunters one male Serow whole body sale in NRs 3000-5000

Participatory Threats Analysis

Habitat Fragmentation & Land Use Change

Development of agriculture area, high dependence of local people in Serow habitat for fuel wood, timber, increasing hotels, trekking routs, increasing of settlements area and increasing distance of forest has played a critical role for habitat fragmentation which has brought critical change in the wildlife profile of the study area in the long run. These habitat fragmentations have negative impacts on the continued survival of the Serow and other different wildlife species in the area. In the Ghandruk and Landruk site, village, hotel and other infrastructure development are the main causes of isolating the forest area in the upper site which plays a role in disconnecting the corridor for serow and other wildlife movement in Landruk region to Annapurna region (fig.9).
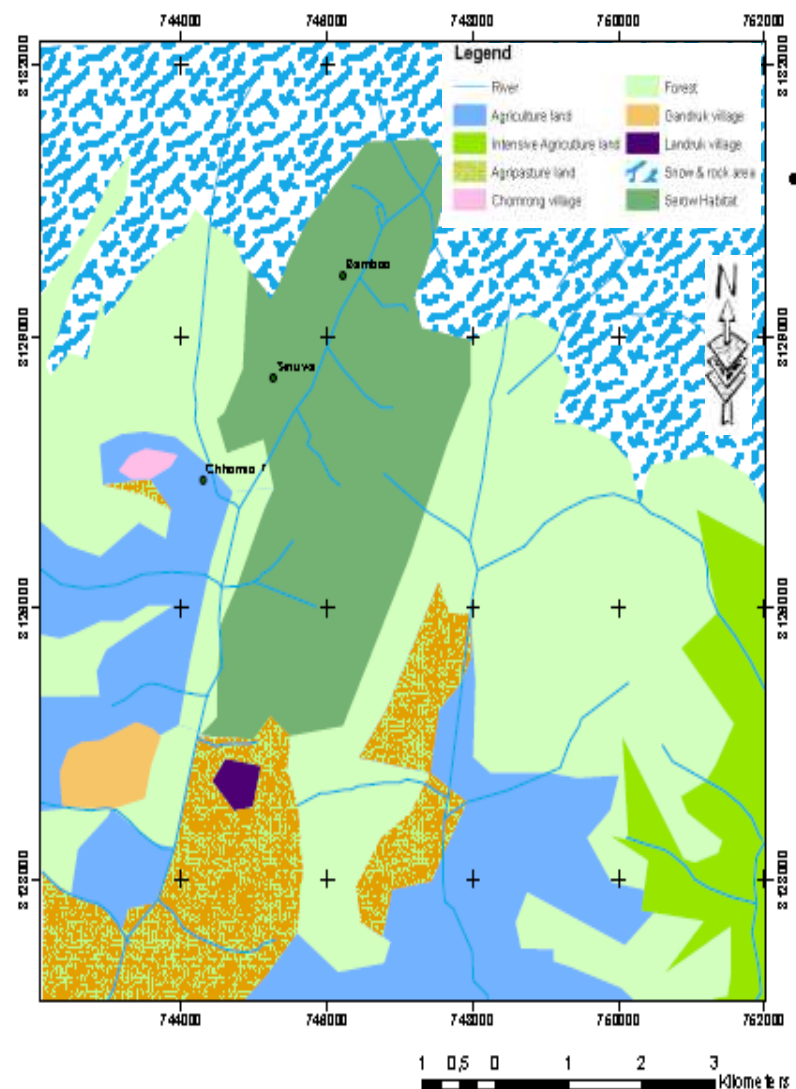

Figure 9: Habitat Fragmentation overview

Decline of Serow Population Conflict between Predator and Villagers

The loss of a large population of the Serow and other ungulates from the study area has created the consequent changes in the abundance of predators species like clouded leopards, common leopard, Brown bear and Black bear. Generally, such predators attack the local livestock only when their natural prey are either depleted or hard to find, so it is one indicator of the decline of the population of serow and other ungulates from the study area. Due to the loss of such preys species, predators of the study area are starting to use villager livestock as feeding species causing major conflict between the villager and predators species in the study area. Within last two years 86 livestock animal have been killed by predators in the area (fig.10), therefore, local people don't like the predators in their area as compare with ungulates and poachers mostly prefer poaching predators species such as clouded leopards, bears of the study area rather than the Serow.
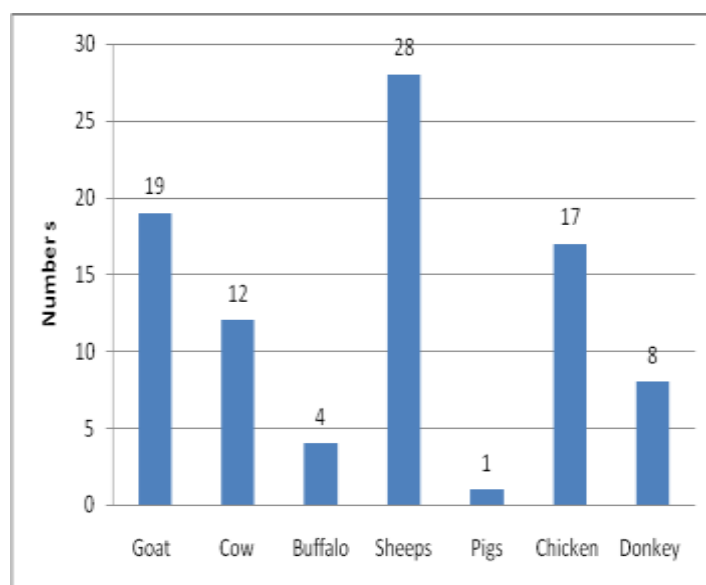
Figure 10: Livestocks kills by predators in past 2 years (n-86)

Livestock Grazing in Serow habitat

Owing to high seasonality and low primary productivity, the Himalayan region supports a relatively low ungulate / herbivore biomass (Aryal, 2005). It is therefore obvious that with the increase in the biomass of domestic livestock in many areas, wild ungulates such as Serow have suffered competitive exclusion. Most of the study area has livestock grazing pressure in the Himalayan and Deurali area where less impact by livestock grazing, only 2% of livestock dung were found in those areas. Others areas have approximately equally influence by the livestock grazing. So it seems that resource competition between serow and livestock high in the area which is another major threat to the serow population and its habitat for survival in

natural habitats.

Poaching of Serow

Serow poaching is another main threat in the study area. Generally poachers prefer not to hunt serow- they only use this species if they cannot find others species because serow meat is not taste compared with other ungulates. As a result hunting is limited and secretive. We found many snares in study area especially in the bamboo and deurali-rich sites where there is a high population of serow.

Conservation Education Parts

Introduction

'Without the management of people, we can conserve natural resource' this was main theme of conservation education programme. Conservation education programme was focusing to raising conservation education or awareness level of local people towards the conservation of Himalayan Serow and mountain ungulates.

In this regard BRTF with the support of PTES, UK and Rufford Small Grant Programme, UK, conducted Serow conservation education activities in Landruk and Ghandruk VDC of Kaski district.

The main thrust of the project was to promote conservation education and conservation of mountain ungulates specially Serow. It aimed at recognizing the perception of local people towards the conservation of Himalayan Serow and raising conservation awareness among local people. Conservation awareness was raised by providing awareness class, poster publication & distribution and workshops with the local people specially, youth, women and students.

Conservation Education Activities

Posters Publication and Distribution

Posters with the title of 'Save the Himalayan Serow' had published under the project (picture 4). Poster on Himalayan Serow has published in size of 19*21 sq. inch. Total 1000+500 posters were published. Posters were able to extend knowledge about Serow and its threats in local people. In fact, there was not any information on this species and this project able to initiate to follow information about this species, so in future researchers, students will start work in further research work on this species. Further more than 600 pieces of posters were distributed in Government of Nepal, Department of National Park and Wildlife Conservation, Annapurna Conservation Area (ACA), Manasalu Conservation Area (MCA), Tribhuvan University, Institute of Forestry-Department of park recreation and Wildlife management, IUCN Nepal, WWF Nepal.

Poster has handover to Director of Annapurna Conservation Area Project to distribute poster in different schools of project area and their unit field office.Posters were distributed in study area's schools student, local people and Annapurna conservation office to distribute other potential serow habitat area. 500 pieces of poster were handover to ACA office to distribute potential area (picture 3).

Picture 3: Poster handover to ACAP director

Poster published under the project.

Himalayan Serow's Poster Presentation in the 4th International Wildland Fire Conference, Spain

The 4th International Wildland Fire Conference was held in Sevilla, Spain, 14-17 May 2007. The conference brought together 1531 participants from 88 countries from throughout the world, representing government organizations and civil society from all regions of the world, the United Nations and other international organizations. The conference was held under the auspices of the United Nations International Strategy for Disaster Reduction (UNISDR), the Food and Agriculture Organization of the United Nations (FAO) and the European Commission and hosted by the Government of Spain and the Regional Government of Andalusia.

The Poster on Himalayan Serow was presented at this conference (Pic.5 & 6). Poster (Pic.4) produced by The Biodiversity Research and Training Forum (BRTF) was presented together with the posters of Global Wildland Fire Network (Regional Wildland Fire Networks). Poster was followed the message on its threats: poster was highlighted intentional forest fire in its habitats, poaching, habitat destruction and deforestation in its habitat. 1531 participants from 88 countries were visited through the poster and gave interest to its conservation.

The Poster was prepared by The Biodiversity Research and Training Forum Nepal with the support of People's Trust for Endangered species, UK; GFMC, Germany; IUCN/SSC-

Picture 4: International conference participants' in front of Serow poster

caprinae specialist group.

For more information about the conference please visit the conference website: http://www.fire.uni-freiburg.de/sevilla-2007.html

Picture 5: Himalayan Serow poster presentation Mr. Sundar Sharma in front of poster

Conservation Awareness

Conservation awareness classes were taken in Himalayan Secondary School for the Eco-clubs members and others student from the class of 8, 9, and 10. Awareness classes were taken in series of workshop in informal ways for 4 days; it was started from March 15 2008. Every day 3 hour class were taken to encourage to student for conservation of Serow in their forest. Main themes of the awareness classes were provided information on Serow and it important to schools student and youths of the area. Classes were taken in following topic

1. Introduction of Wildlife of Nepal and specially focus to study area's animals.

2. Serow and its status in landruk area.

3. Role of student, local people and eco-club for the conservation of Serow and its ecosystem.

4. Future strategy of eco-club for the conservation of Himalayan Serow. Eco-club action plan were prepared through the workshops.

Picture 6: Researcher Taking Conservation Awareness classes

Art and Essay Competition

Himalayan Serow Art and Essay competition was carried out in Himalayan Secondary School Lumle-8, Tolka in the period of March April2008. Altogether 51 (24 in Essay competition+27 in Art competition) were participated in Art and Essay competition. Topic for Essay was *Wildlife for Future: Himalayan Serow and it conservation measurement/issue*, total 24 students from 6 to 9 classes were participated in essay competition. Similarly, 27 students were participated in Art competition; Students were draw art on Serow and wildlife. Project had provided colour pencils, papers, and pens for each student. Prizes were

distributed 1st, 2nd, 3rd and 4th students in each competition.

Essay writing competition

Conservation education activities were started with an essay writing Competition. The essay with its topic "Wildlife for Future: Himalayan Serow and it conservation measurement/issue" it was conducted in Himal higher secondary school, Tolka, Landruk. In this competition altogether 24 students were participated. Although the time was of only one hour and there was no word limit, the participants came up with some really good essays and our judges was thoroughly impressed by the overall standard of the essays.

Art competition:

Art competition was conducted in where the students with their exceptional artistic talent competed for an attractive first prize of Rs 2000 on the theme "Serow and its Biodiversity". Altogether we had 27 students participating in the Art competition.

Figure 11: after conservation education programme in study area

Conservation awareness class by team leader

Formation of Eco-Club:

Introduction:

The concept of Serow Conservation Club (Eco Club) is put forth with the aim to make direct participant of school students, where Eco means 'ecological' and Club means 'group of people'. Eco Club is made in school in which is a free group or union of Students. This group of students can perform different kind of awareness program about of their around which is aimed to help to conserve environment.

A Serow Conservation Eco Club was formed in Himal Secondary School, including the youth of surrounding villages. Information was given to the students about serow habitat Environment, Ecosystems, Serow, Importance of serow, Conservation Issues and BRTF NGO work.

From class 6 two students and from class 7 to 10 three students each were elected for Eco-club head by their classmates – all students of the school will be members of the eco-club. The Eco-club will be supported by School Principal and Local people as well as BRTF, whereas BRTF has provided administrative, technical and scientific support. Training has given to help the students feel self-responsible and ensure continuity of conservation efforts in long run at local level.

Eco club Formation, Execution, and Aim
Aim:
Eco Club is a group for environment conservation, so its first aim is to help to conserve the nature of our surroundings along with this, Himal Eco-club has set aim as given below:

- ❖ To develop awareness for the importance of Serow and natural environment among school students.
- ❖ To inform students about different levels of environment problems such as local and national, regional or worldwide problems.
- ❖ To help to conserve Serow and its associate biodiversity in their area.
- ❖ To help to identify personal role for Serow /environment conservation.
- ❖ For the participation of students to environment-conservation of their around.
- ❖ To exchange the experience among students through green gift exchange program.

❖ To develop students personality.

❖ To help to know students about society.

Formation and Execution

The Eco Club formation in a school is free and it does not remain under the control of any government or non government organization. BRTF has established Eco Club with the coordination of School principle.

According to its establishment and execution Eco Club is a free union but to join to the national and international concept of Eco Club it has to follow certain norms.

Eco Club is a union of all students who are studying in the school. It must establish after the discussion and agreement of all students and teachers. And Eco Club has to follow the basic concept of Eco Club as given below:

❖ Eco Club is the common union of all students who are studying in the school.

❖ This club has one executive committee which contains president, vice-president, secretary, treasurer along with seven to fifteen board members.

❖ Club has to make clear rules about the formation, execution, aim, work, duty and right of execution members and other members.

❖ Club has to distribute general membership according to that rule.

❖ General committee meeting should be held a time in one year. In this meeting annual work report and finance report of the club should submit. And this meeting can reform executive committee who are elected by the general members. But not the board alone but all the general members i.e. all students should be active for the activities and conservation of club.

❖ Head master of the school will be the guardian of the club. And any two teacher will be the advisor of the club. In each meeting of club advisor teacher (i.e. eco teacher) must be invited.

Constitution of Eco Club

Eco club must have one constitution written about the formation, execution, aim, work, duty and right of the board members. That constitution should cover the point mentioned below:

❖ Clear mentioning of the work, duty and right of the chair person, vice-chair person, secretary, treasurer, and the board members of the club.

❖ It should manage work, duty and right of general assembly meeting.

❖ It should manage work, duty and right of advisor teacher (eco teacher).

❖ It should explain clearly about the source of fund collection and its conduction.

❖ It should also manage about the process of formation on the executive committee of the club, numbers of the members, meetings, situation of the blank post and its fulfillment etc.

Constitution is the law of the club; it should cover every aspect including the conduction of the club. So while making this, teachers and other specialists should be consulted.

Fund Collection and Conduction

Fund collection:

Eco club has its distinct treasure. The source of fund may be different. It should identify and search its source of fund itself. These fund should be collected in one account and should use according to its necessity. Eco club has to manage two type of fund:

1. regular expense to run club
2. Projects and programs expense

For these two kinds of expense, club can collect fund from different source:

Regular fund to run club:

This is the regular expense of any club. Stationary expense, letters, telephone, fax, e-mail etc. Bills for newspaper and magazine expense and similar kind of expense are the regular expense of the club. The main source of this expense can make to general members. While making member, club can collect dividing according to the class with fixed amount for the membership. Except this, club can ask to the school and local donor also.

Eco club can collect fund thrugh exhibition, selling of hand made materials from students and selling of plants from their won nursery also.

Project and Program Cost:

The project and program cost of eco club is different from the regular expense. For this

expense, club collects fund from distinct source. Club can find organization and other personal donor for the good and effective activities. But, club must have good knowledge about the project and programs it is going to run and what kind of NGO and other donor help fot that. Eco club can get fund from the sources givel below:

1. School for donation
2. Students for charity and lucky draw
3. Parents for charity and lucky draw
4. ex-students for charity, lucky draw, sponsorship and donation
5. Local donor for charity
6. Government and non government organizations for donation and sponsorship
7. local businessmen and business association and industries for donation and sponsorship
8. Selling of the goods make by the students.

To ask fund from them, club should not ask charity or donation directly. It should first submit proposal explaining why club needs their helps. In that proposal it should cover points like what kind of project or program it is, what benefits students and community get from that and for that why government or organization has to help. Except these, club has to show the amount it needs and the expense estimate of that amount through one proposal. According to that proposal only fund should asked from person, organization or business association or industries. While asking fund from business association or industries, it can put them as sponsor because they are all the time thinking about the promotion of their business or manufactured goods through advertisement. Eco club can find sponsor according to its project or programs. But, the thing it should be careful about is, it can not give pressure to sponsor without written proposal. Club has to take help by convincing to the donor.

Under basic concepts of eco club, BRTF has formed an eco club in Landruk reason for the first time for serow conservation. This club is established in Himal secondary high schools which covered the youths of the serow habitat. The name of the club is Himal Eco Club which is made for the environment conservation of. According to the concept of eco club, headmaster of the school as the patron and two teachers as advisor (eco teacher) and one executive committee of 12 members all together.

Figure 12: Eco club executive members with schools principle

Participatory conservation action plan

It has was prepared in Nepali language so that local people and CMAC can use it easily main part of action plan has listed as short term and long term plan.

Action Plan Prepared by Local People:

Short Term:

a. Locating Serow habitat:

   With participation of local people probable habitats of Serow will be located and map will be prepared.

b. Awareness about Serow conservation:

   Many people don't know about Serow . They don't know the usefulness and importance of Serow. At first they will be informed and told about the importance of Serow .

c. Awareness development among CAMC and local people.

d. Importance and utility of Serow will be institutionalized.

e. The things which are disliked by Serow will not be done like firing, cutting trees etc.

f. Discussion will be done about importance and benefit from Serow in general meeting.

g. Serow habitat will not be destroyed:

   Probable habitats like tall and dense trees will not be cut, bamboo clump will not be cut, rocks and stones will not be removed, forest and den firing will be restricted.

h. More information will be collected about Serow :

   More research will be conducted on Serow . So that more useful things about Serow could be found out.

i. Information about Serow will be extended through different media:

   Importance of Serow will be extended via different media like telephone, radio, television and printing media so that more and more people understand value of Serow in ecosystem.

j. More people will be informed about importance of Serow .

k. Forest fire will be controlled.

Long Term:

a. Sustainable management of Serow habitat:

Serow conservation can be possible by managing Serow habitat in proper way. Serow habitat can be managed in many ways like planting plant species which is preferred by Serow s, not cutting bamboo, restriction in use of chemical pesticides, restriction forest and den fire, sustainable use of forest products.

b. Trees/grasses management:

Food for Serow can be managed by planting species which is liked by Serow like bamboo tree, and other species and plants whose leaf and by Serow .

c. Research and education about Serow , like its diet and management.

d. Seeking help from donor organization:

Most of the long term actions plan requires budget for conduction of plans. So help should seek from donor agencies.

e. Upliftment and development of tourism industry:

Focus should be given on Serow conservation for the development of tourism industry. Many tourists may visit Landruk to watch Serow and its scenic beauty, which help in upliftment of economic status of local people.

f. Formation of network for Serow conservation.

g. Conservation committee formation:

Conservation committee should be formed so that they can contribute more in Serow conservation by awarding people and informing people about usefulness and importance of Serow in ecosystem.

h. Awareness development through coordination with different organization:

Different organizations should be united together with local people for the Serow conservation by conducting different workshops, awareness programs.

i. Sub-committee should be formed for conservation of Serow locally.

Conclusion and Recommendation

Himalayan Serow **'***Capricornis sumatraensis. Thar'*** is a threatened, solitary mammal of Asia. This is first study on this species which was also able to raise conservation education among the local people. The study has collected baseline data on this species and changed local people's attitudes towards the conservation of the serow in its natural habitat. The research has generated a baseline for further research on this species.

The population of Serow is only concentrated in the southern part of ACA region especially in Ghandruk and Landruk region, therefore the authorities must concentrated more on this species for research and conservation. Feeding ecology and its relation with predators is the most important area for further study to understand its feeding behavior. Co-existing patterns with predators and other ungulates in the area is another necessary area for further research.

The serow population is isolated in a small patched of the southern part of Annapurna Conservation Area (ACA) with a population density of 1.17 individual/km^2 and sex ratio of 7:11(Male: Female). There was a strong correlation between population (y) and pellet density (x) (*$Y=0.011x-0.2619, R^2-0.97$*). This equation can be used for further monitoring of this species in natural habitats. Therefore, the present study is reflecting the small population in the study area, and more study is essential on other side part of Nepal. We don't know about home range, reproductive behaviors of this species so work should be carried out as soon as possible for better management of this species. Green (1987b) has reported a total population of 50-100 serow occurring in Bangladesh in isolated and scattered units. The present study showed that population density (1.17 individual/km^2) is slightly small then to Green's 1987 study of India.

Generally, Government and Researchers are focusing on wildlife like Tiger, Rhino, Bears, Snow leopards, etc, that have high economic and illegal market value. These species are easier to raise funds for from international sources. That's the reason behind lack of research on low illegal market value species like Serow, Hispid hare, etc. Therefore, concerned agencies (Government/NGOs, INGOs, Civil Society) and researchers must give equal emphasis in-situ conservation of low illegal market values species such as serow, which is a prey species for threatened species like leopards.

The altitude preference of the serow depended on disturbance but positive correlation was found with different altitude preference (R2-0.5212): most preferred altitude was 2500 to 3500 meters (Ivlev's Value (IV)-0.44). The serow prefers gentle to steep slopes with the increasing Ivelv's value by 0.1 to 0.3 but weak correlations between them (R2-0.16). The serow mostly prefers dense forest (IV- 0.27), with descending order of preference being rocky (IV-0.19), cliff (IV-0.17), and Cave (IV-0.09) with weak correlation (R2-0.0096). There was significant difference in the use of different habitat parameters such as altitudes (F-0.0001, P<0.001), slopes (F-0.0013, P<0.001) covers (F-0.001, P<0.001), crown covers (F-0.001, P<0.001) and ground covers (F-0.001, P<0.001) proportional to available habitat parameters.

In total 23 tree species, 14 shurbs and 32 herbs were recorded on serow habitat. The serow showed preference for 11 trees species in its habitat which were used for feeding & cover (thermal & hiding) purposes and, of them Michalia Champaca, (IVI-36, I-0.17), Rhododendron arborium (IVI-40; IV 0.11), Ilex dipyrena (IVI-33; IV-0.16) were most important and preferable to the serow. Plants species were not used in proportion to their availability {Trees (F-1.428, P-0.369), Shrubs species (F-88.869, P-0.083) and herb species (F-0.459, P-0.895)}.

The major problems in Serow habitat were habitat fragmentation & land use change; loss of serow population, conflict between predator and villager, livestock grazing in serow habitat and poaching of serow.

Conservation education was the most effective tool to raising serow conservation awareness among the local people. The project was successful in giving information on the present status of Himalayan Serow in the ACA.

Further research and conservation education are important for conservation of this species.

Rufford Evaluation Form Report

Grant Recipient Details	
Your name	Achyut Aryal
Project title	**Status and Conservation of Himalayan Serow (*Capricornis sumatraensis. thar*) in Annapurna Conservation Area of Nepal**
RSG reference	**10.07.07**
Reporting period	August 2007 to August 2008
Amount of grant	£3170
Your email address	savefauna@yahoo.com
Date of this report	1 September,2008

1. Please indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
To determine the population Status of Himalayan Serow in study area.			√√	
To quantify habitat use and distribution pattern of Himalayan Serow (Habitat Suitability Analysis) using GIS technique.			√√	
To assess past and present the poaching activities and trade pattern of Serow in study area.			√√	
To map out distribution and potential poaching area in ACA			√√	
To raise conservation awareness among the local as well as national people.			√√	
To analysis the threats on Himalayan serow population and its habitats through the participatory approached			√√	
To Prepare participatory Himalayan Serow conservation action plan through the involvement of local people			√√	

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled (if relevant).

No

3. Briefly describe the three most important outcomes of your project.

a. Project able to collect basic ecological information on this species which is first attempt in country as well as in Asia.

b. Project able to raise conservation awareness, form eco-club, published poster on this species and prepared conservation action plan for conservation of this species in ACA.

c. Project able to prepare monitoring model for serow in future through the pellet density of the serow.

4. Briefly describe the involvement of local communities and how they have benefitted from the project (if relevant).

In each step of the project local people were involved, in field research time 15 local people were involve for silent drive count. These people known that how to do it in future, and how carried out the pellet survey and habitat survey in its habitat. Conservation education programme were others part which provide knowledge about serow conservation and its important in our ecosystem. Around 200 schools students and youth are benefited from conservation education programme. And poster has distributed in local and different part of country.

5. Are there any plans to continue this work?

There should be detail study on this species on ranging pattern, diet analysis and its predators for future management of this species.

6. How do you plan to share the results of your work with others?

The project technical paper has been submitted to different international journal for review and publication.

7.Timescale: Over what period was the RSG used? How does this compare to the anticipated or actual length of the project?

August 2007 to August 2008

8. Budget: Please provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used.

Item	Budgeted Amount	Actual Amount	Difference	Comments
DSA and Travel Principle investigator DSA and Travel field assistance 1 person (ranger level) One local	**900**	1500	-600	

knowledgeable person for DSA for 10 people for silent drive count for				
Internet, Email, Phone, Fax	100	300	-200	
Data entry, analysis, computer typing etc	100	300	-200	
Photo copy, printing, banding, photos, reals, Serow tery, photos developing.	100	300	-200	
GPS, Compass, Binocular,spotting scope measuring Tape, Tents	320	800	-430	
GIS Map Preparation, Topo-maps, Food for 3 person 120 days in field	500	**800**	-300	
Medical insurance for PI and Field assistance @ £150	150	**150**	0	
Conservation education programme	1000	**1700**	-700	
Total	3170	**5820**	-2650	

Partial fund for this project has provided by PTES, UK and remaining has covered by BRTF, Nepal

9. Looking ahead, what do you feel are the important next steps?
There should be detail study on this species on ranging pattern, diet analysis and its predators for future management of this species.

10. Did you use the RSGF logo in any materials produced in relation to this project?
Did the RSGF receive any publicity during the course of your work?
In case activities of the project, I used RSGF logo. During the project, I have published poster on serow with RSGF logo which has distributed in local, national and international level.
11. Any other comments?

12. I agree to this report being published on the Rufford Small Grants website

    Signed (or print name)_____Achyut Aryal _____

References

1. Aryal, A. 2005. Status and distribution of Musk Deer 'Moschus chrysogaster' in Annapurna Conservation Area of Manang district. A report submitted to ITNC, UK.

2. Aryal, A. 2006. Musk Deer 'Moschus chrysogaster': Population and conservation status, distribution, habitat structure, poaching in Annapurna Conservation Area (ACA) Kobang VDC of Mustang district of Nepal. A report submitted to British Ecological Society, UK, 2006

3. BPP, 1995. *Red Data Book of the Fauna of Nepal*. Biodiversity Profiles Project Publication No. 4. Department of National Park and Wildlife Conservation, Ministry of Forest and Soil Conservation, His Majesty's Government of Nepal., Kathmandu

4. Chapagai, D & Dhakal, J., 2002. " *CITES Implementation;* Department of National Parks and Wildlife Conservation & WWF Nepal Program, pp 133.

5. Fox, J. L. & Johnsingh, A. J. T., 1997. Country report on India. *in* Shackleton, D. M. (ed) & the IUCN/SSC Caprinae Specialist Group. *Wild Sheep and Goats and their Relatives. Status and Conservation Action Plan for Caprinae*. IUCN. Gland, Switzerland and Cambridge, UK. pp 215-231

6. Green, M. J. B., 1987b. The conservation status of the leopard, goral and serow in Bangladesh, Bhutan, Northern India and Southern Tibet. Unpublished report by IUCN Conservation Monitoring Center for the United States Fish and Wildlife Services. pp 26

7. Green, M.J.B. 1985. Aspects of the ecology of the Himalayan Musk deer. Ph.D. thesis, University of Cambridge, Cambridge, UK. 280 pp

8. HMG/Nepal, 2002. Nepal Biodiversity Strategy (NBS), His Majesty's Government of Nepal, Supported by GEF and UNDP.

9. IUCN 2004. *2004 IUCN Red List of Threatened Species.* <http://www.iucnredlist.org/>. Downloaded on 24 February 2006.

10. Mahato, N. 2003.Habitat preference of Himalayan Serow, *Capricornis sumatraensis thar* (Hodgson,1831) in Gandruk VDC of ACA, A report submitted to IUCN country office, Nepal.

11. Shackleton, D. M., 1997. Country report on China. *in* Shackleton, D. M. (ed) & the

IUCN/SSC Caprinae Specialist Group. *Wild Sheep and Goats and their Relatives. Status and Conservation Action Plan for Caprinae*. IUCN. Gland, Switzerland and Cambridge, UK. pp 148-172

12. Trevel, A., Andriamampianina, L., Didier K., Gibson, J., Plumptre, A., Wilkie, D., Zahler,P., 2004. A simple, cost-effective method for involving stakeholders in spatial assessments of threats to biodiversity. COEX: Sharing the Land with Wildlife, Inc. 6010 South Hill Drive Madison, WI 53705, USA (www.coex-wildlife.org)

13. Wegge, P. & Oli, M.K., 1997. Country report on Nepal. *in* Shackleton, D. M. (ed) & the IUCN/SSC Caprinae Specialist Group. *Wild Sheep and Goats and their Relatives. Status and Conservation Action Plan for Caprinae*. IUCN. Gland, Switzerland and Cambridge, UK. pp 231-239.

14. Wollenhaupt, H., Green, M. J. B., Thinley, S. & Palden, J., 1997. Country report on Bhutan. *in* Shackleton, D. M. (ed) & the IUCN/SSC Caprinae Specialist Group.

15. Wiens. J.A 1984. Resource systems, populations, and communities. Pages 397-436 in P.W. Price, C.N Slobodchikoff, and W.S. Gaud, eds. A new Ecology: novel approacheds to interactive systems. John Wiley and sons, New York. N.Y.

16. Hall, L. S., P. R. Krausman, and M. L. Morrision. 1997. The habitat concept and a plea for standard terminology. Wildlife Society Bulletin 25:173-182.

17. Krebs, C. J. 1989. Ecological methodology. Harper and Row, New York, New York, USA.

18. IVLEV (V. S.), 1961. - Experimental ecology of the feeding of fishes. Yale Univ. Press, New Haven. 302 p.

19. ACAP, 2002. Annual Report. Annapurna Conservation Area Project.

20. Poudel, B. S., 2003. An assessment of status of *Rhododendron* in Ghandruk-Ghorepani region of Annapurna Conservation Area. A research report submitted to Annapurna Conservation Area Project/ KMTNC, Pokhara, Nepal.

21. Prater, S. H., 1993. *The book of Indian Animals*. Bombay Natural History Society, India.