

**AN ASSESSMENT OF HUMAN-WILDLIFE
INTERACTION IN THE INDUS VALLEY, LADAKH,
TRANS-HIMALAYA**

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CERTIFICATE

This is to certify that the thesis of **Ms. Shivani Chandola** entitled "AN ASSESSMENT OF HUMAN-WILDLIFE INTERACTION IN THE INDUS VALLEY, LADAKH, TRANS-HIMALAYA" is an original piece of work submitted to the Saurashtra University, Rajkot (Gujarat), for the award of the Doctor of Philosophy in Wildlife Science.

Ms. Shivani Chandola has put in more than six terms of research work embodied in this thesis under my guidance and supervision. The work presented in this thesis has not been submitted to any other university or institution.

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J.F. Kennedy

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SUMMARY

Protected Areas (PAs) are cornerstones of ecosystem conservation and critical to achievement of 2020 Aichi Biodiversity Targets. However, the efforts to conserve natural ecosystems through the establishment of PAs have resulted in conflicts of land use and livelihoods, due to increased instances of interaction between human and wildlife. The term “interaction” implies both negative and positive association between human and wildlife. While wildlife threatens the local economy, the consumptive (e.g. sale of timber, fuel and NTFP) and non-consumptive resource use (e.g. tourism income) from the PA provides the opportunity to forego the losses due to wildlife’s presence.

The Hemis National Park, in the “Ladakh mountains” Zone 1A, presents such a case of human-wildlife interaction, where the Snow leopard (*Panthera uncia*) and the Tibetan wolf (*Canis lupus chanko*) are known to be the major cause of livestock losses to the agro-pastoral communities of this region. On the other hand, the livestock grazing and tourist influx have been cited as challenge for habitat and wildlife conservation. The magnitude of human-wildlife interaction in the Ladakh region necessitates the need for a combination of socio-ecological studies for better understanding of the dynamics of human-wildlife interaction for sustainable co-existence.

The present study was designed to improve upon the existing knowledge on the human-wildlife interactions in Ladakh. The major objectives of the study were to (i) study the pattern of resource use and its contribution to livelihood of local communities in Trans-Himalayan landscape; (ii) evaluate

the pattern of conflicts arising from resource use practices by the local communities and its impact on wildlife values; (iii) examine the existing education systems and religio-cultural teachings in their ability to address the conservation issues of the region, and (iv) to examine the existing policy instruments and suggest improvement to minimize such conflicts. The thesis addresses the following key questions; (a) How do people in Hemis landscape derive their livelihood and what is the contribution of HNP's resources in the total income of the residents? (b) Do these livelihood options affect wildlife values in the surrounding areas? (c) What conflicts exist that affect the conservation goals? (d) How much loss is incurred by the local communities due to such conflicts? (e) Are these losses being off-set by the income from non-consumptive resource use? (f) How do the existing education systems, viz. formal and informal, address conservation issues? (g) What is the scope of policy instruments in achieving the conservation goals?

The assessment of natural resource dependency and sources of livelihood for the local community residing inside the HNP was carried out during 2005-2006 using data generated through questionnaire surveys, personal observations and secondary sources. A total of 108 households, representing 72.5% households inside the HNP were visited and interviewed.

Subsistence agriculture is the main livelihood of the people. Livestock, tourism, remittances, and traditional craftsmanship were other sources of income. Income from tourism varied significantly along the village clusters of HNP ($\chi^2 = 28.33$, $df = 3$, $p \leq 0.001$). For Markha and Rumbak tourism contributed the most towards total income. For Chilling and Shang village

clusters remittances formed the major contributor to family income. Tourism based income source of residents of Rumbak were the most diverse, followed by residents of Markha, Chilling and Shang valleys ($\chi^2 = 46.9$, $df = 9$, $p \leq 0.001$).

Firewood, dung, vegetable collection and grazing within the Park's boundary are the major form of resource use by the local people for self use. Dependency score generated by adding the number of resources (either firewood, dung, vegetable or grazing or in combination) used by the households was highest for Markha and Rumbak village clusters ($\chi^2 = 74.36$, $df = 12$, $p \leq 0.01$).

Higher dependency of residents Markha and Rumbak's on resources of the Park and income from tourism makes them vulnerable to environmental change. Therefore, the management must focus on the ways to meet the need of the people to maintain the integrity of the habitat. Prescribed rotational grazing with specified number of livestock in the area could be one way to reduce the pressure on habitat. Promotion of community based tourism could be another option to reduce the dependency of local communities on natural resources. The tourism plan for the area must ensure continuous flow of tourism benefits to the local people, through proper monitoring and evaluation of the community based tourism.

In the study area the abundance of natural vegetation such as *Aconogoum tortuosum*, *Artemisia spp.*, *Caragana*, *Carex*, *Dracocephalum*, *Kobresia*, *Potentilla*, *Rheum* were found to increase in proportion with increase in elevation while the abundance of weed species such as *Echniops*,

Nepeta leucolaena, *Physochlaina praealta* were found to decrease with increasing distance from human habitations and increasing elevation. High abundance and density of *Kobresia* in the mid distance zone suggests higher grazing pressure.

In the study area the occurrence of large ungulates viz. Ladakh urial (*Ovis vignei vignei*), Tibetan argali (*Ovis ammon hodgsoni*), Siberian ibex (*Capra ibex siberica*) and Wild Ass (*Equus kiang*) was restricted to a smaller areas while the population of Blue Sheep/Bharal (*Pseudois nayaur*) was found all along the trek routes and human habitations of the HNP. Eight trails of length from 2 to 4 km were monitored twice during 2006 for getting information on ungulate species found along the 52 km trek trails of the HNP. The encounter rate and mean group size of Blue sheep was found highest for the Rumbak valley and mid-distance from the village hamlets.

Higher abundance of Blue sheep and of weed species at mid distance from permanent human habitations, suggests that the Blue sheep utilize lower productive grasslands, as higher productivity grasslands were occupied by the livestock re-emphasizing the theory of competitive exclusion of wild ungulates from productive habitats. The rotational grazing as suggested and traditional migratory grazing practices could reduce the competition between wild ungulate and livestock. Zonation of critical wildlife habitats could also be considered to reduce competition for forage and space. This would mean delineating trek routes where livestock and pack animal movement needs to be kept minimal to avoid disturbance to wild ungulate habitat.

During 2005-06 the assessment of the losses to the local community was made through the questionnaire survey in the human settlements inside the HNP. Of 108 households, 58.3% incurred losses due to predation, 41.7% suffered livestock death due to disease and 19.4% reported extreme cold conditions as the cause of livestock death. An annual loss of 4.81 ± 6.47 livestock head per family was recorded. Highest loss, due to all three factors combined together, was noted for families living farthest from metalled road [$F(3,104) = 2.859, p \leq 0.05$]. Snow leopard was the predator in 70% instances of livestock predation. Most of the livestock predation (49%) was reported from summer pastures. Crop damage in the HNP was attributed to wild ungulates (86%) and to landslides (13.7%). All the households located far from metalled road reported crop damage by the ungulates. Crop depredation was highest in the month of April-May when the crop was tender. Small and scattered agricultural fields make guarding difficult and inefficient.

The monetary loss due to livestock predation amounted to 12.5% of the total income. Highest monetary loss as percent of total income was noted for village hamlets located at a distance of more than 20 km from metalled roads. The main source of income for the households in this category is livestock and tourism hence livestock predation makes them more vulnerable to livestock predation losses.

Of 72 households dependent on the Park's resources 60% households obtained higher returns from tourism income compared to the losses associated with livestock predation ($\chi^2 = 22.090, df = 3, p \leq 0.001$). For a large percent of households (60%) tourism income was able to offset the predation

losses. The highest percentage of households for which predation losses could not be compensated were from villages located near the metalled roads since these households were either not obtaining significant tourism income or obtained no tourism income. Tourism in the study area is providing economic returns as preferable compensation for livestock loss in some parts of the study area. The direct payments received from tourism is being used for improving social capital of the region, as large number of children from the study area were observed to temporary migrate out of the study area for job or studies. Higher returns from tourism is found to have increased tolerance level of the local communities as they take pride in living in the wildlife habitat and being part of the conservation community. The residents of Shang village cluster rarely are involved in tourism activities. The monetary losses incurred to them appeared to be significant in proportion of their income since most of them were primarily dependent on agriculture. Due to main settlement's location off the trek-route, nearness to the city and trek-operators' own resources had been cited as the reason by the residents of these settlements for not receiving direct benefits of tourism. In case of no direct benefit of eco-tourism from the HNP in lieu of the losses due to livestock predation, the residents could easily get lured to the idea of expanding their agricultural fields. This could further intensify the losses to the residents of this particular settlement, where crop loss, at present is reported by every household. Ways to provide incentives to these villagers could include popularizing the off-trek routes as cultural and wilderness area, for an experience of Ladakhi lifestyle. Local products made by the residents could also be promoted for sale to the tourist groups for enhancing incomes.

The role of formal education system to address conservation issues was analyzed through the content analysis of the government school textbooks of grade 5th to 8th. Presence of information on environmental issues; global examples; local specific examples; provision for interpretation in context of local socio-ecological linkages scored 1 each for each textbook and the absence of these scored 0. Hence, the score ranged between 0 to 8, for each parameter. The textbooks scored maximum for the presence of environment issues and global examples in all grades. The scores for local examples and linkages provided in the textbooks was only 12.5% of 8. Presence of Ladakh specific information was provided through single chapter in the geography textbook of grade VII, under the chapter 'Life in the Desert Region'. The textbooks available to the students of Ladakh do address environment issues, however these fail to address the local specificity of the environment and conservation issues, nor do they provide information on linkages to the local socio-ecological processes.

The teachers of Ladakh were aware about the basics of flora and fauna and had favorable attitudes towards them. Closer scrutiny of the individual attitude statements revealed that the native teachers had unfavorable attitudes towards large carnivore such as snow leopard. The unfavourable attitude can be accounted to the life experiences of the teachers where they have grown up in a community, dependent on livestock rearing and any damage to the livestock causes significant economic loss. Despite this unfavorable attitude the teachers agreed with the possibility of mutual co-existence. The religio-cultural upbringing of the teachers in Ladakh as Buddhist explains this attitude.

The interactions with religious teachers and scholars, as well as literature and personal observations revealed that plants and animals are used as symbol for religious teachings in form of storytelling. Buddhism teaches the philosophy of “*ahimsa*”, and prohibits killing of animal and thus is considered as preacher of co-existence. Scholars have attributed Buddhism to be the factor responsible for tolerance of local communities of the Ladakh or for the superstition due to which the Buddhist herders believe depredation results from deities they or the community angered.

Spreading awareness among the residents of HNP on the range of benefits that they could receive in lieu of co-existence with the wild animals, through community awareness and sensitization program, religious teachings and bringing up local specificity in the text-books of school children could result in sense of pride and belonging among the residents of HNP. The local community in the present study has a literacy rate of 53% and hence instilling conservation message through formal education system would be impractical and wasteful. However, since the local communities are strongly influenced by the Buddhism philosophy, the religious leaders could provide the message of conservation and may help in designing community specific conflict mitigative strategies and conservation plan for the area. Also, there is need to spread awareness among general public, tour-operators, tourists and the government officials, so as to bring all of them to similar platform of understanding the need to provide incentives to the local community of the HNP or any other PAs of the region.

Policy and vision documents of various sectors having an implication for conservation of natural resources *viz.* Forest Policy, Wildlife (Protection) Act, J&K Kahcharai Act, Management Plan of the HNP, LAHDC's Vision document and the literature available on discourse of policy dealing with human-wildlife interaction reveals that the J&K's forest policy's objectives to conserve the biodiversity and natural habitat along with poverty alleviation of the forest dependent communities provide scope for the participatory management of the resources in the Rumbak and Markha catchments. The policy provides opportunity for mitigating human-wildlife conflict through restriction of human activities inside the core habitat areas; inter-sectoral co-operation, partnership and participation of local institutions and awareness creation. The LAHDC's 2025 vision statements are in support of conservation of natural resources of Ladakh and revival of sustainable society.

The policy instruments allows for both mitigative and preventive measures to minimize negative human-wildlife interaction, through sustainable incentive program such as promotion of sale of handicrafts, and payment made to local communities towards the pastoral area foregone for conservation, as already underway in Rumbak valley. Some of the suggested mitigative and preventive measures are - enforced following of the traditional grazing rules; restricted grazing by migratory livestock in critical wildlife habitats; demarcation of grazing and non-grazing areas or core and buffer areas in PAs; providing equal opportunities to households and village clusters which incur significant monetary losses; periodic maintenance of predator proof corrals; allocation of households to take turn to guard the fields; regular health care check-up of the livestock; spreading awareness among the

residents of HNP on the range of benefits that they could receive in lieu of living with the wild animals; awareness creation among general public, tour-operators, tourists and the government officials, so as to bring all of them to similar platform of understanding the need to provide incentives to the local community of the HNP or any other PAs of the region.

Hence, despite the presence of regulatory measures in terms of policies and acts, there is an immediate need of land use planning for the areas surrounding the study area, since growing need to improve the agricultural outputs in the villages totally dependent on agriculture could drive them to intensify the agricultural practices and take up measures, such as fencing, which could act as barrier for easy movement of the wild ungulate across the habitat. Land use planning for the village clusters is needed and where present it should be documented, so as to maintain the areas specific for grazing, trek trails, wildlife habitat. However, while marking the trek trails for tourists, care should be taken to provide equal opportunity to all the residents within the HNP.



Chapter 1

HUMAN-WILDLIFE INTERACTION

“Humans are fundamentally and to a significant extent irreversibly, changing the diversity of life on Earth, and most of these changes represent a loss of biodiversity”

MA 2005

1.1 INTRODUCTION: HUMAN-NATURE INTERFACE

A large number of studies carried out, in recent times, reinforce the fact that nearly all natural ecosystems of the world are under pressure due to extensive human use (e.g., Gadgil 1990, Kryuchkov 1993, Hannah et al. 1994, Mittermeier et al. 2003, Bawa et al. 2004, Imhoff et al. 2004, Cardillo et al. 2006, Bremner et al. 2010, Harris 2010). The Millennium Ecosystem Assessment (MA 2005) critically examined the conditions and trends of the ten major ecosystems of the world and confirmed that rapid and extensive use of resources by humans, in the last five decades had resulted in extensive change of ecosystem, leading to irreversible loss of biodiversity. Reports of MA (2005) and many other scholars have time and again emphasized on maintaining healthy ecosystems for sustainable well-being of human.

With the studies confirming rapid degradation of natural ecosystems and their declining resilience, the need of the new millennia is to enhance and contain ecosystem capacity, conserve and protect biodiversity, through legal, political and socio-ecological interventions, such as creation and maintenance of

Protected Areas (PAs) (Bruner et al. 2001, Rodrigues et al. 2004, Chape et al. 2005, Ehrlich & Pringle 2008, Loucks et al. 2008, UNEP-WCMC 2008). There are more than 140,000 PAs worldwide, covering over 12.7% of earth's land surface (IUCN & UNEP-WCMC 2012) representing one of the most significant resource use allocations on the planet.

The analysis carried out by Leroux et al. (2010), suggests that at global level, the PA network does not necessarily represent absolute pristine habitats and recommends creation of new PAs and maintenance of existing PAs according to the IUCN guidelines since these PAs act as major control sites for detecting the effects of disturbance caused by human beings. Shift in focus from simply conserving the biodiversity to maintenance of natural ecosystem and improving their efficacy in providing basic needs of societies worldwide (Dudley & Stolton 2003, Adams et al. 2004, Kothari 2006, Holland 2012) at all scales has further enhanced the need to have and manage the pristine ecosystem and represent these through the PAs. Despite existence of disturbances within PAs, their efficiency to conserve and protect the biodiversity represented by different eco-regions of the world is acknowledged globally (Brooks et al. 2004, Rodrigues et al. 2004, Chape et al. 2005, Naughton-Treves et al. 2005, Pyke 2007, Jenkins & Joppa 2009). Additionally, the role of PAs to reduce poverty, provide livelihood and food security, maintain ecological sustainability has been discussed at great length by scholars in view of the Millennium Development Goals (MDGs) (Dudley & Stolton 2003, Roe 2003, Adams et al. 2004, Kothari 2006, Holland 2012).

Globally, protection of land under terrestrial PAs has gone up from 3.48% in 1985 (Zimmerer et al. 2004) to 12.85% in 2009, with Brazil accounting to 74% of the global increase in PAs since 2003 (Jenkins & Joppa 2009). The PAs world over represents the global biodiversity hotspots and the mountain ecosystems harbor almost half of them (Korner & Spehn 2002), with 32% of PAs of the world being located in the mountain regions. These PAs have been classified and defined on the basis of degree of protection and degree of human use allowed within them, thus the PA category ranges from the strictly protected nature reserves (corresponding to IUCN category Ia) allowing no human use to newly introduced Community and Conservation reserves (corresponding to IUCN category VI) allowing overlap of human and wild landscapes.

In India protection of natural resources dates back to 252 B.C., when sanctuaries for wild animals were set up under rule of Emperor Ashoka (Panwar & Mathur 1991). Indian Emperors, Mughals and then the British also reserved areas for varied reasons. Creation of world's first National Park 'Yellowstone NP' in United States, in the year 1872 gave new dimensions to management of natural resources (Keiter 1991). India's first national park was set up in 1932 and named Hailey's National Park, now known as Corbett National Park (Kothari 1997). Today India has a vast network of Protected Areas (PAs), with 102 National Parks (NP), 515 Wildlife Sanctuaries (WLS), 49 Conservation reserves (CRs) and 4 Community reserves covering 4.9% of country's geographical area (WII 2012).

The Indian PAs have very rarely been free of human interference and activities. In late 80's when India's population was far less than 1 billion, and the number of PAs was about 200 less than the present number then also 69% of the Indian PAs were reported to have people living inside them (Kothari et al. 1989). Approximately same percent (70%) of the human population was reported from PAs across the globe (Ghimire & Pimbert 1997). Recognizing presence of communities within the landscapes categorized as protected, the IUCN introduced categories of the PAs on the basis of management objectives and degree of human interference. Despite this classification of PAs, nearly all the categories of PAs are found to have some instance of human activities (Leroux et al. 2010). The Indian National Parks correspond to the highest degree of protection (IUCN category II) legally prohibiting extractive resource use within its boundary. Despite this, human presence (settlements) and *de-facto* resource use from the national parks has been reported from previous decades (Kothari et al. 1989), till recent times (Mishra 1997a, Bhasin 2011). The use of PAs' resource ranges from fulfilling basic requirements of food, water and shelter to economically driven land use and associated changes, such as grazing livestock for its products, timber and medicinal plant extraction. The process of extracting resources and changing land use practice disturbs the biodiversity, by impacting the wildlife habitat (Turner 1996, Spangenberg 2007).

1.1.1 'Human-wildlife conflict'

Human-wildlife conflict (HWC) usually emerges as a result of intimate interspersed of people with wildlife (Rodgers 1989) and also due to competition for scarce resources. According to the World Conservation Union (IUCN 2003). HWC results from overlap of wildlife's requirement of space and food with that of humans', creating losses to resident communities and wild animals. More recently, the World Parks Congress suggested HWC to denote the situation where the needs and behaviour of wildlife have negative impacts on humans' goal or when the goals of humans negatively impact the needs of wildlife (IUCN 2003).

Since, many PAs are inhabited by the local communities, either living in the periphery or within them, there tends to be competition between humans and wildlife for the resources that are equally essential for survival of both life forms. HWC are not of recent origin, but evidence suggests an increase in hostile encounters in recent years (Sawarkar 1986), "due to increasing human population, loss of natural habitat and in some regions increasing wildlife population as a result of successful conservation programmes" (Rodgers 1989, Saberwal et al. 1994). The present day human-wildlife conflict emerges in new settings where resource scarcity, economic imbalance, increase in human population challenges conservation goals and ecosystem sustenance (Limenh 2007), and frequency and severity of such impacts are predicted to intensify (Madden 2004).

HWC are frequently rooted in issues like poverty, overpopulation and lack of options for local livelihoods and are largely due to lack of involvement of stakeholders in planning, management and decision making, unclear property and tenurial rights of the communal lands. A list of driving forces for escalating HWC is given by Distefano (2005), which in short are:

- Human population growth
- Land use transformation
- Species habitat loss, degradation and fragmentation
- Growing interest in ecotourism and increasing access to natural reserves
- Increasing livestock population and competitive exclusion of wild herbivores
- Abundance and distribution of prey
- Increasing wildlife population as a result of conservation programmes
- Climatic factors
- Stochastic events

These driving forces are linked with each other in several ways, making it a web, and thus there is need to address these forces in a holistic way, rather than treating them as separate entity.

Rodgers (1989), summed HWC as “Human against wildlife”, “Wildlife against humans” and “administrative conflicts” i.e. people–people conflict or more specifically conflicts between the PA authorities and the local communities and inter-department issues. The “wildlife against humans” conflicts are manifested in form of crop raiding, livestock predation, property damage, human injury and death (GOI 2001, NBSAP 2002), on the other hand the “humans against animals” conflicts occur in form of loss or decline of wild ungulate population by driving them to areas of sub-optimal habitat (Ranjitsinh 1981, Osborne et al. 1983, Chundawat & Qureshi 1999).

According to FAO’s report “human-wildlife conflict poses threat to many globally endangered species for e.g., Sumatran Tiger (*Panthera tigris sumatrae*), the Asiatic Lion (*Panthera leo persica*), Snow Leopard (*Panthera uncia*), Red Colobus Monkey (*Procolopus kirkii*) (Distefano 2005). Ogada et al. (2003) stated that the species most exposed to conflict are more prone to extinction. Wildlife mortality due to human’s interference disturbs the ecosystem equilibrium and thus has much wider implication on the environment.

1.1.2 ‘Human-wildlife conflict’ or the ‘human-wildlife interaction’ dogma

The term conflict implies that there is conflict of interests and in case of HWC the conflict is between human well-being and conservation goals. The HWC represents the larger and overall conflict between “people and parks”.

Peterson et al. (2010), says that the term “human-wildlife conflict” represents the terministic screen, wherein the term HWC directs attention towards conscious antagonism between wildlife and humans. Depending upon the situation of resource and resource users the terms ‘human-wildlife co-existence’, “human-wildlife conflict” and “human-wildlife competition” has been used by Madden (2004), Marshall et al. (2007) Matthiopoulos et al. (2008) respectively. The term “co-existence” describes peaceful existence despite differences; “competition” defines situation where the same environmental resource is demanded/required by two or more types of organisms and the term “conflict” describes an antagonistic action by the group of organisms which causes one group to suffer. Thus, in all at least two parties must be involved and one of these tries to get benefit and the other suffers from elimination of the resource (Bennett et al. 2001, Marshall et al. 2007). Peterson et al. (2002) and Yasmi et al. (2006), views that competition between humans and wild animals over use of limited natural resources has lead to the emergence of idea of conflict by humans, since the wild animal species use the resources just for their survival, without any intentional threat to human survival, thus, the term “human wildlife conflict” represents just the human side of the story.

The term “interaction” implies both negative and positive association between human and wildlife. It would be more pragmatic therefore to replace the term ‘conflict’ with ‘interactions’, so as to indicate a situation to be negative or positive depending on the benefits or losses to the humans and wildlife, as a result of interaction with each other.

For the purpose of this thesis I will be using the term “interaction” rather than “conflict”, as the purpose of the study is to assess the type of interacting conditions under which human and wildlife could co-exist. Keeping in view the driving forces for negative impacts of human wildlife interaction, it is clear that negative impacts of human wildlife interaction will not end in near future, the only pragmatic solution to it lies in the act of managing the conflict, rather than trying to eradicate it. Site specificity, multi-stakeholder involvement, varying spatio-temporal levels and information, market and policy failures inhibit ability of the managers to deal with HWC (Mishra 1997a, Naughton-Treves 1997, Wolch & Emel 1998, Knight 2000, Nyhus et al. 2000). A study by FAO (Distefano 2005) outlines the HWC management strategies as either preventative or mitigative. Where the mitigative strategies attempt to reduce the level of impact and lessen the problem, the preventative strategies try to prevent the conflict occurring and then take action towards addressing its root causes. Use of artificial and natural barriers to prevent overlap of land-use by wildlife and humans, guarding and monitoring of the livestock, voluntary human population relocation are some of the preventive strategies that are used world over to reduce the negative impacts of human wildlife interaction. Compensation schemes, insurance programs, subsidy based incentive programs, community based natural resource management schemes, regulated harvest and wildlife translocation are some of the mitigating strategies followed in some countries. A combination of site-specific strategies is needed to contain negative impacts of human wildlife interaction.

1.2 REVIEW OF LITERATURE

Vast amount of studies on people-wildlife interface have been carried out across the major wilderness areas globally. To understand the concept of human wildlife interaction and interface, it is necessary to first look into the factors associated with such interactions i.e., the ecological limitations and associated resource use, economically driven resource use and sociology of resource utilization.

All societies worldwide are dependent on Earth's limited resources, which are often non-renewable. In the era of post-modernization, the communities living in the forested area are extensively using the resources for their day-to-day subsistence. Direct use of resources obtained from PAs by the local communities ranging from dependence for food, fire, shelter, fiber, livestock health and wealth, have been the focus of many studies (Dixon & Sherman 1991, Fiallo & Jacobson 1995, Badola 1999, Awasthi et al. 2003, Baral & Heinen 2007, Chandola et al. 2007). Indirect use or rather non-consumptive use of the resources from the PAs has also been subject of study by many scholars (Badola & Silori 1999, Campbell 1999, Archabald & Naughton-Treves 2001, Stem et al. 2003; Stone & Wall 2004, Sandbrook 2010). Studies carried in the villages and settlements in the Rajaji National Park and the corridor of Rajaji and Corbett National Park (Semwal 2006, Chandola et al. 2007, Ogra & Badola 2008) found that people are largely dependent upon nearby forests for domestic and subsistence resources. Mallon (1991) reported that the natural resources in Ladakh were widely used for

obtaining direct benefits for self-use. Awasthi et al. (2003) cited changes in cropping pattern and increased cattle to land ratio as major factors that has increased pressure on resources in the Himalayas. For the *Bhoitya* tribe of Uttarakhand, collection and selling of the medicinal herbs was observed to be one of the sources of the income, constituting 12-13% of total income to the villagers (Farooquee & Saxena 1996).

Dependence on natural resources has been attributed to a number of factors ranging from free availability of resources, traditional use and due to lack of alternatives to the resources. Communities living in the Nanda Devi Biosphere Reserve (NDBR), India, were found to be totally dependent on natural resources, mainly due to remoteness in location (Badola & Silori 1999), while in the Rajaji-Corbett forest corridor, dependency of local people on forest resources was due to lack of alternative livelihoods and social, economical and cultural factors (Badola 1998, Chandola 2001). These studies in addition to the studies by Silori (2001), Baral & Heinen (2007), indicate that human's dependence on resources has socio-economic and spatio-temporal dimensions. In NDBR dependency of the local people on the biomass resource of the buffer zone forest varied according to the seasonal and altitudinal migration, where a little more than half the population residing in the biosphere reserve were dependent for six months and the rest were dependent on resources for fuel, fire wood, throughout the year (Silori 2001). Another constantly rising indirect pressure on the natural resources and local capacity is due to the tourism industry. Studies such as, Sah & Mazari

(2007), Uniyal & Singh (2011) have reported more than 200% increase in the number of tourists in some parts of Himachal Pradesh, India.

Continued and indiscriminate use of resources has led to the changes in land use patterns, results of which are reflected in the loss of biodiversity and biodiverse rich areas. Increased human population has further resulted in fragmentation of wild habitats, resulting in matrix of overlaps between natural landscapes and humanscape (McCloskey & Spalding 1989, Primack 1993, Laurance & Bierregaard 1997). The close interspersed of human and wild animals has resulted in increased rate of interaction between human and wild animals, where both often compete for land and food resources, leading to situation of competition. Overlap of human habitation and wild habitats along with development changes has brought in breakdown of traditional livelihood systems, which was based on sustainability principles. With this breakdown, the impact of extensive resource use is being felt in terms of degradation of the ecosystems and the landscapes and thus this dependence on natural resources is jeopardizing the renewable resources and the ecological services as well as associated values provided by them (UNEP 1999, MA 2005). Huddleston et al. (2003) raised concern that the breakdown of traditional routes and degradation of resource base coupled with developmental changes has increased vulnerability of traditional livelihood systems of mountain people, making both natural resource base and the people's well-being at risk.

Livestock grazing is another form of traditional human use of natural landscape, which has consequences on grazing by the wild ungulates in the same landscape. The impact of livestock foraging on the density and diversity of wild herbivore has been studied well in different ecosystems and biomes of the world. Competition between wild ungulates and livestock is an important aspect of human-wildlife interaction, which has led to local extinction through exclusion from a habitat. Mishra et al. (2002), concluded that four main ungulate species viz., Wild yak, Kiang, Tibetan Argali and Chiru may have been driven to extinction in Spiti, Trans-Himalaya, due to competitive exclusion by livestock. Similarly, study by Bagchi et al. (2004) in the Trans-Himalayas revealed that goat and sheep impose, resource limitation for Ibex and thus exclude them from certain pastures. Another study (Namgail 2004), found that Argali shifts its habitat in response to livestock presence. Johnsingh & Negi (2003) explained that tiger extinction in the Bijnor forest division, India, to one or a combination of several factors such as conversion of natural vegetation to Eucalyptus plantations, human disturbances including *gujjar* settlements, poaching and cattle grazing. Vaidyanathan et al. (2010) in Tadoba Andhari Tiger Reserve, India observed that the distance to the human settlements influenced disturbances to flora and fauna, with larger human settlements indicating higher disturbance. Fritz et al. (1996) found that impala *Aepyceros siceros* shifted to refuge habitats in the presence of cattle in African savanna woodland. The biomass extraction has negatively impacted the native avifaunal in tropical dry forests. Structural features such as canopy cover, tree basal area and the average height of trees, which are

indispensable part of faunal habitat were found to decline significantly due to anthropogenic disturbance in Sariska Tiger Reserve, India (Shahabuddin & Kumar 2007). In Rajaji National Park, India Harihar et al. (2009) demonstrated that increased anthropogenic pressures inhibited tiger population recovery in the western sector of the park, compared to the eastern sector of the park, where tiger recovery was observed to be quick following relocation of the *Gujjars*.

Presently the issue of geographical overlap of PAs with local populations is major conservation challenge. Cincotta et al. (2000), estimated that in 1995, 20% of the world's population were living within the 25 biodiversity hotspots and 16 of these hotspots, including India's had population densities at or above world's average. However the conservation implications on livelihood of the local people still need to be fully understood at individual regional context, due to heterogeneous nature of the human communities and thus making conservation initiative more sites specific. Human have been losing their property (livestock, crop, lives) to the wild mammals since long, under varied situations involving a range of diverse mammals. The intensity of loss and resulting retaliation among the local communities against the wild mammals is high in tropics and developing countries (Distefano 2005), as livestock and agriculture form the backbone of economy and people are dependent on natural resources for their sustenance, thus making the resident human population vulnerable. Most of the damage incurred by the local communities can be attributed to the carnivore species, since these have large home ranges (Treves & Karanth 2003). In Africa, livestock

predation occurs due to Lions, Leopard, Cheetah, Hyena (Naughton-Treves 1997, Butler 2000, Patterson et al. 2004). In Asia, Asian lions (Vijayan & Pati 2002), tigers (Sekhar 1998, Nyhus & Tilson 2004), leopards, snow leopards (Hussain 2003, Mishra et al. 2003, Wang & Macdonald 2006) are reported to have caused psychological and economic losses to resident people. Lynx and wolves are reported to cause losses to people in American (Stahl et al. 2001, Musiani et al. 2003) and European continents (Cozza et al. 1996), whereas crop raiding and associated loss is attributed to elephants, wild pigs, deers, rhinoceros, monkeys across all the continents (Naughton-Treves 1997, Siex & Struhsaker 1999, Madhusudan 2003, Ogada et al. 2003, Zang & Wang 2003, Spiteri & Nepal 2008).

The losses incurred by the local communities have financial as well as psychological implications (loss of sleep, fear, restriction of travel). Economic costs attributed to such losses amount from 12% of the family income for livestock predation as reported from Zimbabwe (Butler 2000), to 30% of family income in Karnataka, India due to livestock predation and crop loss (Madhusudan 2003). According to Karanth & Nepal (2011) wildlife caused damage affected 90% of the households in five PAs, across India and Nepal. In Chitwan National Park, Nepal 90% of the households reported crop losses due to the wildlife (Spiteri & Nepal 2008). Rao et al. (2002) found that crop damage varied from 18% to 60% depending on location of the field with respect to the forested area in NDBR, India. Whereas, livestock depredation was attributed to

the leopard especially in cases where the livestock were left unaccompanied. Karanth & Nepal (2011) found that average loss of income per household due to the crop loss varied from INR 6,834 annum⁻¹ in Kanha National Park, India to INR 24,025 annum⁻¹ in Nagarhole National Park, India. Between 1977-1991, in Gir National Park, India, 193 lion attacks on human (14.8 yr⁻¹) and 28 lion caused human mortalities (2.2 yr⁻¹) have been reported. More lion attacks (82%) were reported outside the PA boundary (Saberwal et al. 1994). In Rajaji National Park, India, seasonal crop damage due to wild animals ranged from 20-50% with 100% respondents believing that human wildlife conflict decreased the amount of food grain and milk available for domestic consumption. 35% respondents claim to lose at least one animal in leopard attacks (Ogra & Badola 2008). In Spiti valley, India each family loses about 1 animal/yr (Bagchi & Mishra 2006), 18% of livestock were reported to be predated by wild carnivores in less than 2 years and the loss of livestock amounted to half of the annual per capita income (Mishra 1997a). Namgail (2004) reported 7% livestock predation over a period of two and half years, in proposed Gya Miru Wildlife Sanctuary, Ladakh, India. Mean annual depredation loss/household was found to be about 5 livestock in Zaskar, Ladakh, India (Jayapal 2001). In Hemis National Park, India about 12% of livestock was reported to be killed by predators over a period of 14 months (Bhatnagar et al. 1999). 21.2% of households in villagers in Jigme Singye Wangchuck National Park, Bhutan, suffered losses amounting to 2.3% per annum of their livestock holding, which accounted to 17% of their total per-capita cash income (Wang & Macdonald 2006). In southern India, which has wild

elephant population of about 6000-7000, crop damage was estimated to be about 6.5 million Indian rupees during 1981-1983 (Sukumar 1989). Additionally are the costs borne by the local communities, which are incurred as strategies for preventing conflicting situation, through predator control, guarding and better livestock herding techniques (Thirgood et al. 2005). Costs of protection and better herd management involve costs required for purchase and installation of infrastructure, costs of maintenance. Schumann et al. (2006) estimated that the cost associated with protection of livestock on commercial farms of Namibia was US\$ 1733 km⁻¹year⁻¹ and US\$ 513 (cost of installation, costs of maintenance of electric fence and swing gates, respectively). Specific breed of guard dogs, ammunition, corrals and sheds maintained for guarding the herd involves huge costs. Additionally, communities living in zone of human-wildlife interaction, bears the “opportunity costs”, reflected in terms of time spent on herd guarding, which otherwise would have been used in other activities, such as attending school by the children of the family; working in fields or in tourism activities (Norton-Griffiths & Southey 1995). Limited access to the resources due to presence of wild carnivore in the neighboring area, further adds to the costs borne by the communities in benefits foregone. In Madagascar, communities living close to Mantadia National Park had to forego over half of their annual per capita income, resulting from restricted access to their farms (Sandbrook 2006).

Where communities have not been able to contain and tolerate the negative impact of wildlife on their livelihoods, there the local communities have

taken extreme steps to eradicate the population of culprit species (Menon et al. 1998, Tuytens et al. 2000). These actions substantially affect the carnivore populations, thus undermining the conservation goals (Woodroffe et al. 2005). In past, lethal control of problematic species has resulted in their extinction, e.g., Falklands wolf (*Dusicyon australis*) got extinct in 1876 (Macdonald & Sillero-Zubiri 2004), Carolina Parakeet (*Conuropsis carolinensis*) and the Thylacine (*Thylacinus cynocephalus*) got extinct in 1904 and 1930 respectively (IUCN 2002, Woodroffe et al. 2005). Decline in carnivore populations, in conflict zones, can also be attributed to lethal control. Cheetah populations (CITES 1992, Marker 1998), wild dogs (Fanshawe et al. 1991), African lion (Bauer et al. 2003) have observed global decline and range contractions resulting from their eradication coupled with factors responsible for habitat loss, degradation and fragmentation. Carnivore population management through eradication, regulated harvest or preservation, are some of the practices used world over. Treves & Karanth (2003) reviewed the use of these strategies and found that carnivore management is a political as well as scientific challenge. They concluded that a mix of strategies involving nonlethal modification of carnivore behavior, change in human behavior have to be used by the managers. Sustainable use and conservation-based incentives are emerging as the perceived viable tools for managing the conflicts (Hutton & Leader-Williams 2003, Distefano 2005, Madden 2008, McNeely & Mainka 2009). According to Hutton & Leader-Williams (2003), cultural values play significant role in nurturing wildlife conservation as part of human life. Similarly, societal taboos and religious beliefs regarding certain

species and areas e.g. *Van Devi* has resulted in habitat and species preservation in India (Gadgil & Vartak 1974). Religious teaching and philosophy may also shape communities' tolerance to the carnivores and other nuisance predators. Ale (1998) observed that non-violence teachings of Buddhism made the local Buddhist population living in Manang, Nepal tolerant to high incidence of livestock predation by snow leopard. Similarly Koshal (2001) noted that nature forms an intrinsic part of the Ladakhi folk traditions, which predominates with the message of maintaining harmony with the nature. This was in contrast to the observations made by Hazzah (2006), where he noted that people following the evangelical teachings of the Kenyan Assemblies of God (KAG) church harbored hostile attitude towards carnivore. Closer introspection of local religious followings and teaching provide an understanding of the nature friendly or otherwise attitude of communities, their livestock herding and livelihood practices. This community specific knowledge may help in designing strategy to mitigate conflicts in a particular region. Knowledge about the carnivores and other wild species is said to increase tolerance level among the people (Ericsson & Heberlein 2003). This knowledge can be attained through traditional or the modern education systems. Tiblisi declaration (UNESCO 1977) recommends integration of environment education into formal and non-formal education system. Thessaloniki declaration (UNESCO 1997) suggested scientific community to play an active role in strengthening content of education. There is growing recognition of incorporation of environmental concerns in textbooks and Indian National Curriculum Framework (NCERT 2005) provides an opportunity to

include environment concerns in formal education system. But how conservation issues are reflected in religious teachings and textbooks of local syllabus is not known for the Ladakh region.

From the case studies it is clear that negative human wildlife interaction is on rise due to a number of driving forces, all of which are inter-related. Growing human population, resultant transformation in land use triggering species habitat loss due to degradation and fragmentation, increasing livestock population, increased access to nature reserves, increasing wild animal population due to better conservation programmes are some of the factors escalating the human-wildlife competition and conflict. At the same time, better knowledge regarding the wild animals, traditional and cultural teachings, livelihood diversification are some of the mitigative techniques that can be used for eliminating and reducing human wildlife conflicts.

Comprehensive policy instruments that would work in coherence with other instruments and with inter-department alliances are required to contain HWC. Policy institutions play a very significant role in reaching a desired objective, be it of conservation or improved livelihood options, there are multiple agencies who deal with the various policies and with little consideration of the linkages between livelihood and conservation. If institutions are to respond to local subsistence need and sustainable natural resource management then monitoring mechanism and management arrangements need to be adapted to changing local context (Wakeel et al. 2005). Mishra (2000) emphasized the need

for conservation policies to be sensitive to transient nature of local human communities. State policies are adoption of GOI policies without mountain focus and thus lack coherence (Gulati & Gupta 2003). Inter and intra-departmental conflicts have made policies ineffective (Saberwal 1999).

Developmental policies have implications for the communities' socio-economic structure, their well being and changes in their traditional systems. Ives & Messerli (1989) and Fox et al. (1994) noted that ubiquitous presence of military, rapid growth of civil administrative structures and tourism has resulted in replacement of subsistence economy with the heavily monetized economy in Ladakh. Though these changes are more pronounced in the towns and large villages, located at the road heads, however they have implications for the remote villages, affecting the aspirations of the communities. Mallon (1991) further observed that low human density, low level of hunting and the existence of some uninhabited and undisturbed areas, in the region had helped in maintaining resilience of the ecosystem. It has been argued that concomitant changes in people–landscape interaction (changes in livestock holding and grazing pattern, resource utilization – fuel and fodder collection) have fundamentally resulted from the social and economic changes, directly affecting natural resource conservation.

The notion of creating protected areas to protect the floral, faunal species and the ecosystem and restrain inconsiderate use of these resources by humans has been one of the milestones in 20th century. Durbin & Ralambo (1994) talk

about the major lacunae in planning a PAs *i.e.* overlooking human needs and aspirations of the local population and the lack of mechanisms to deal with ensuing conflicts. Developing policies and strategies to minimize and contain situations of human-wildlife conflict aiming at maintaining ecosystem integrity and securing livelihoods of local communities is dependent on a complete understanding of intricacies of local humanscape and wild landscapes. Trans-Himalayan region of India, represents an extremely fragile ecosystem, inhabited by snow leopard, the keystone species of the Himalayas. This species along with Tibetan Wolf have been reported to be in constant conflict with the local communities, co-habiting in this region.

The ecological studies in the Ladakh region has generated modest amount of information on the endangered species of the region, e.g., Fox et al. (1991), Mallon (1991), Shah (1996), Chundawat & Qureshi (1999), Anon (2001), Bhatnagar & Wangchuk (2001), and studies have been conducted to quantify losses due to wildlife in the region (Mishra 1997a, Bhatnagar et al. 1999, Jayapal 2001, Jackson & Wangchuk 2004, Bagchi & Mishra 2006) but nonetheless site specific information provides information which would assist in better understanding of human-wildlife interaction, causes of conflict and framing conflict mitigation strategies as well as relevant policy development.

The present study was thus intended to assess the dependency of community living in the Hemis National Park (HNP), the extent and condition of interaction with the wildlife. The study also probed into the efficacy of the

education system and policies in dealing with the conservation issues specific to the region. The information generated through this study will contribute to improved understanding of the human-wildlife interaction continuum and in framing the strategy for continued co-existence of humans with wildlife.

1.3 OBJECTIVES OF THE STUDY

The aim of the study is to understand the patterns of conflicts arising from existing resource use and suggest ways to minimize such conflicts in the Trans-Himalayan region of Ladakh.

The main objectives of the study are:

1. Study the patterns of resource use and their contribution to livelihood of local communities in Trans-Himalayan landscape
2. Evaluate the patterns of conflicts arising from resource use practices by the local communities and their impacts on wildlife values
3. Examine the existing education systems and religio-cultural teachings in their ability to address the conservation issues of the region
4. Examine the existing policy instruments and suggest improvement to minimize such conflicts

The hypotheses framed for the study are:

1. There is no difference in the resource use and dependency among different villages and among different households.

2. All the resource use practices contribute equally to the livelihood.
3. There is no difference in pattern of livestock predation and crop damage among different villages.
4. There is no difference in the wildlife values along the resource use gradient.
5. Knowledge and awareness of school teachers are not affected by their personal attributes

1.4 KEY RESEARCH QUESTIONS

1. How do people in Hemis landscape derive their livelihood and what is the contribution of HNP's resources in the total income of the residents?
2. Do these livelihood options affect wildlife values in the surrounding areas?
3. What conflicts exist that affect the conservation goals?
4. How much loss is incurred by the local communities due to such conflicts?
5. Are these losses being off-settled by the income from non-consumptive resource use?
6. How do the existing education systems, viz. formal and informal, address conservation issues?
7. What is the scope of policy instruments in achieving the conservation goals?

1.5 SIGNIFICANCE OF THE STUDY

Only 9.29% of the geographical area of the Trans-Himalayas is under various degree of protection, through PA network, despite the fact that significant wildlife exists outside PAs. The resources are scarce and both human and wildlife are at the mercy of harsh environment. Bhatnagar et al. (1999) reported that in this region even the remotest pasture is used for livestock grazing. In last ten years the land under trees, groves and pastures has undergone a decline of 3%, whereas there has been a corresponding increase of about two hundred thousand livestock population in the region (Finance Commissioner 2001), signifying the increased pressure on the remote pastures and increased vulnerability of the livestock under poorly managed and protected corrals.

The human populations of the region are primarily agro-pastoral or largely nomadic pastoral as in the Tibetan Plateau. Studies suggests that the livestock holding is declining owing to development (Mallon 1991, Saberwal 1999), livestock holding are increasing due to evolving market forces as well as due to state government's policy to increase the number of sheep so as to increase the *pashmina* wool production (Mishra 1997a, Bhatnagar et al. 1999, Bhatnagar & Wangchuk 2001, Namgail et al. 2010a). This increase in the number of livestock would put pressure on the already scarce resources and would also increase the vulnerability to predation by carnivores in absence of any alternative. Studies by Mallon (1991), Chundawat & Rawat (1994), Bagchi & Mishra (2006), found that livestock form the major prey in the diet of wild carnivores, in summers, due to scarce population of wild prey animal in the Trans-Himalayan region. The cattle

loss to carnivores often results in retaliatory killing of wild animals by trapping and meat poisoning (Nath 1982, Mallon 1991). These details are not easy to obtain in the present circumstances due to ban on killing (Mallon 1991). As animal husbandry is the mainstay of economy it would be worthwhile to quantify the loss of livestock in monetary value to know the financial burden caused due to livestock predation.

Till date, only few studies (Mishra 1997a, Bhatnagar et al. 1999, Jayapal 2001), in the Trans-Himalayan region have attempted to quantify the extent of damage to livestock, despite the fact that snow leopard prey on livestock throughout its range (Schaller 1977, Mishra 1997a, Mijiddorj 2012) and is regarded with hostility by the local people, along with threat posed by the wolves (Mallon 1991). The region harbors the most magnificent of the wildlife and has a huge influx of the tourists, the locals derive benefit from this sector, as elsewhere in the world. Jackson & Wangchuk (2004), reported 5000 visitors visiting the Hemis National Park . How the locals receive this benefit vis-à-vis the livestock loss is also an unexplored issue in “human-wildlife interaction”. Also, little information is available on the extent and nature of local communities’ dependency on resources of the park. The proposed study attempts to know whether the communities have economic incentives to conserve wildlife. While a limited number of studies have yielded modest information on the costs incurred to the local community due to wildlife, even less or no information is available on livelihood benefit of wildlife across the proposed study area.

1.6 ORGANIZATION OF THE THESIS

The thesis is organized into seven chapters dealing with various aspects of study. The first chapter outlines the theories of human animal interaction with the help of review of relevant studies. The chapter further summarizes key research questions and the objectives of the study. Second chapter provides description of study area and helps to understand the geo-physical and social landscape of the study area. Chapter three deals with the methodology followed and tools and techniques used for the study. Chapter four provides description of human landscape, and resource use pattern of the study villages, the wildlife values along the main trek trails. Chapter five deals with the issue of human animal interaction, with villagers incurring livestock and crop loss due to wild animals, the economics of loss and benefits. Chapter six describes role of education systems (formal education and religio-cultural) followed in the Ladakh region to address the issue of conservation. Chapter seven describes policy instruments of various sectors applicable to the study area. This chapter further provides an insight on conservation implications of the results provides appropriate recommendations. The alphabetical list of literature cited is given in references section.



Chapter 2

THE STUDY AREA

2.1 INTRODUCTION

The Trans-Himalaya is a cold desert, with an altitudinal range from 2,200 m to above 7,000 m and winter temperatures may drop to below - 40° C. The Trans-Himalaya receives an annual precipitation of 100-1000 mm, which decreases to north and east (Fox et al. 1994). The Trans-Himalayan region in India is divided into three biogeographic provinces – the “Ladakh Mountains” or Zone 1A, the “Tibetan Plateau” or Zone 1B and the “Himalaya Sikkim” or Zone 1C (WII 2009). Most of the Trans-Himalaya in the country falls in the Ladakh region of Jammu and Kashmir (J&K) State, lying between 32°15' to 36° N and 75°15' to 80°15' E. The Indus river with its two primary tributaries – the Zaskar and the Shyok rivers form the primary drainage of Ladakh. The region is also endowed with numerous small and big – brackish and freshwater lakes.

Vegetation of the region is dry alpine steppe, with typical high altitude desert characteristics, making the plant community unique and endemic. The flora of Ladakh is dominated by annuals, perennial herbs and few dwarf shrubs. Growth season starts with onset of summer, which is short (Anon. 2001). Ladakh is home to eight species of ungulates and six species of large carnivores, most of which are recognized as endangered in the Indian Wildlife (Protection) Act 1972 (Anon. 1992) and also globally. Snow leopard (*Panthera*

uncia), the flagship species of the Trans-Himalaya, Lynx (*Lynx isabellina*), Tibetan Wolf (*Canis lupus chanco*), Wild dog (*Cuon alpinus langier*), Red fox (*Vulpus vulpus*) and Brown bear (*Ursus arctos*) are the carnivore species found in Ladakh. Among ungulates, Siberian ibex (*Capra ibex siberica*), Tibetan argali (*Ovis ammon hodgsoni*), Ladakh urial (*Ovis vignei vignei*), Bharal (*Pseudois nayaur*), Tibetan antelope (*Pantholops hodgsoni*), Tibetan gazelle (*Procarpa picticaudata*), Tibetan wild ass (*Equus kiang*), Wild yak (*Bos grunniens*), and feral populations of the Bactrian camel (*Camelus bactrianus*) are found in Ladakh (Bhatnagar & Wangchuk 2001).

Politically, Ladakh is a semi-autonomous region, and administration is run through the Ladakh Autonomous Hill Development Councils (LAHDC) of Leh and Kargil districts. Muslim population predominates in the Kargil District, while followers of Buddhism inhabit the Leh district. In the era of growing population and increasing population density, Ladakh still remains least densely populated parts of the world and India, with human density of 3 persons/sq km for Leh district and 8 persons/sq km for Kargil district (<http://www.censusindiamaps.net>). Human establishments are typically found only near water sources and thus have uneven distribution on the landscape. Clumping of the human settlements is observed in major valleys of Leh, Nubra, Zaskar where the availability of arable land and irrigation is better (Mallon 1991).

Combined mountain agriculture practiced by the Ladakhi population provides them means to sustain in the harsh climatic conditions of limited

agriculture potential (Ehlers & Kreutzmann 2000). Crop farming and animal husbandry, are the two major interdependent components of the combined mountain agriculture, which in addition to the resource (fuel and fodder) collection have been the traditional livelihood options for the local people.

Dame & Nüsser (2011) noted that agricultural season is limited between May to September, during which barley and wheat, the staple crops are cultivated. Being in the rain shadow area, agricultural productivity is dependent on irrigation from snow melt. Rotation of cereal crop with peas and mustard is followed mostly at lower elevations (< 3000 m). Kitchen garden forms usual source of local vegetables such as turnip, cabbage, potatoes, onions, carrots and green leafy vegetables. Since increase in elevation reduces the growing period for plants, single cropping prevails at altitudes of 3000 m and above. Wheat is cultivated up till 3600 m (for Sabu village) (Labbal 2001) and 3800 m (for Stongde village) (Osmaston 1994), barley can be grown at even higher altitude (upto 4400 m) (Osmaston 1994). Land resource is vast and unlimited in Ladakh, but dry and arid conditions limit the availability of arable land. Land ownership has traditionally been vested with Buddhist monasteries and farmers. Crop production result in self-sustenance of the village farmers, the surplus though sometimes as observed by Dame & Nüsser (2011) is used for bartering goods.

Significantly short growing period, producing limited type of crops, has resulted in dependence on livestock products for the rest of the year. Sheep, goats, cattle, yaks, dzo (yak and cow crossbreed), horse, donkeys and mules

are kept for dung supply (which is used fuel and manure) transport, labour, wool and milk and milk products. Livestock form multipurpose and multi-tasking asset for the villagers, where each and every part of animal is utilized, e.g. animal dung is used as fuel and fertilizer, large animals are made to carry load, transporting humans and goods, milk products and meat form an important protein source in the local diet, wool, skins and hides are used for clothing and warming up the house. The list of main livestock along with their characteristics and contribution to the economy is described in Table 2.1.

Table 2.1: Livestock of Ladakh

Name	Gender	Parents		Occurrence	Strength
		Male	Female		
<i>Mule (ti-u)</i>	Male	Horse	Donkey	Frequent	Superior
<i>Dzo</i>	Male	Cow	Yak	Frequent	Superior
<i>Dzo-mo</i>	Female	Cow	Yak	Frequent	Superior
<i>Stol</i>	Male	Bull	Dzo-mo	Rare	Inferior
<i>Stol-mo</i>	Female	Bull	Dzo-mo	Rare	Inferior
<i>Gar</i>	Male	Yak	Dzo-mo	Rare	Inferior
<i>Gar-mo</i>	Female	Yak	Dzo-mo	Rare	Inferior
<i>Zgyir/gyir</i>	Male	Gar	Garmo	Rare	Inferior
<i>Zgyir-mo/gyir-mo</i>	Female	Gar	Garmo	Rare	Inferior
<i>Lok</i>	Male	Zgyir	Zgyir-mo	Rare	Inferior
<i>Log-mo</i>	Female	Zgyir	Zgyir-mo	Rare	Inferior
<i>Ser-ling-zgyir</i>	Male	Lok	Log-mo	Extremely rare	Inferior
<i>Ser-ling-zgyir-mo</i>	Female	Lok	Log-mo	Extremely rare	Inferior

(Source: Modified from Koshal 2001)

Livestock grazing follows the village rules and regulations, where livestock are taken to the traditional pastures. In winters the livestock graze near village on day-to-day basis and in summers they are sent to pastures located at

higher altitudes. Since plant productivity is low and limited to summer months and are used by animals (ungulates and livestock), fodder plants such as Alfalfa (*Medicago* spp.) and dried grasses grown on fields and on sides of the agricultural fields, tree leaves, hay from the crops are used as fodder during winters.

As discussed in the beginning of the chapter, limiting environmental factors do not allow growth of large trees and resultant dense forests. Demand for fuelwood, timber, fodder is met by the small woody tree species such as willow and poplar, which grow naturally at banks of streams and rivers and grown at the farms (Plate 1). Besides these two species, Bhattacharya (1991) noted that naturally growing *Caragana* (*Caragana versicolor*), *Myricaria elegans*, *Arenaria bryophylla*, *Artemisia* spp., *Hippophae rhamnoides*, *Juniperus macropoda*, *Krascheninnikovia ceratoide*, *Myricaria germanica*, were used as fuel for heating and cooking.

Ladakh region had limited influence from outside world till recently, when in 1974 the region was opened for tourists, since then Ladakh has witnessed economic growth resulting from construction of roads, airport and heavy influx of tourists and traders (Fox et al. 1994). Ubiquitous presence of military, rapid growth of civil administrative structures and tourism has resulted in replacement of subsistence economy with the heavily monetized economy. As a result of changes in the development policies, e.g. focusing on intensive production of the Cashmere, the Changthang region of Ladakh experienced unprecedented growth in number of goats and increased pressure on the grazing lands of the plateau (Namgail et al. 2007a).



(a) Poplar trees along the stream in Markha valley, HNP



(b) *Salix* and *Myricaria* spp. along the stream in Rumbak valley, HNP

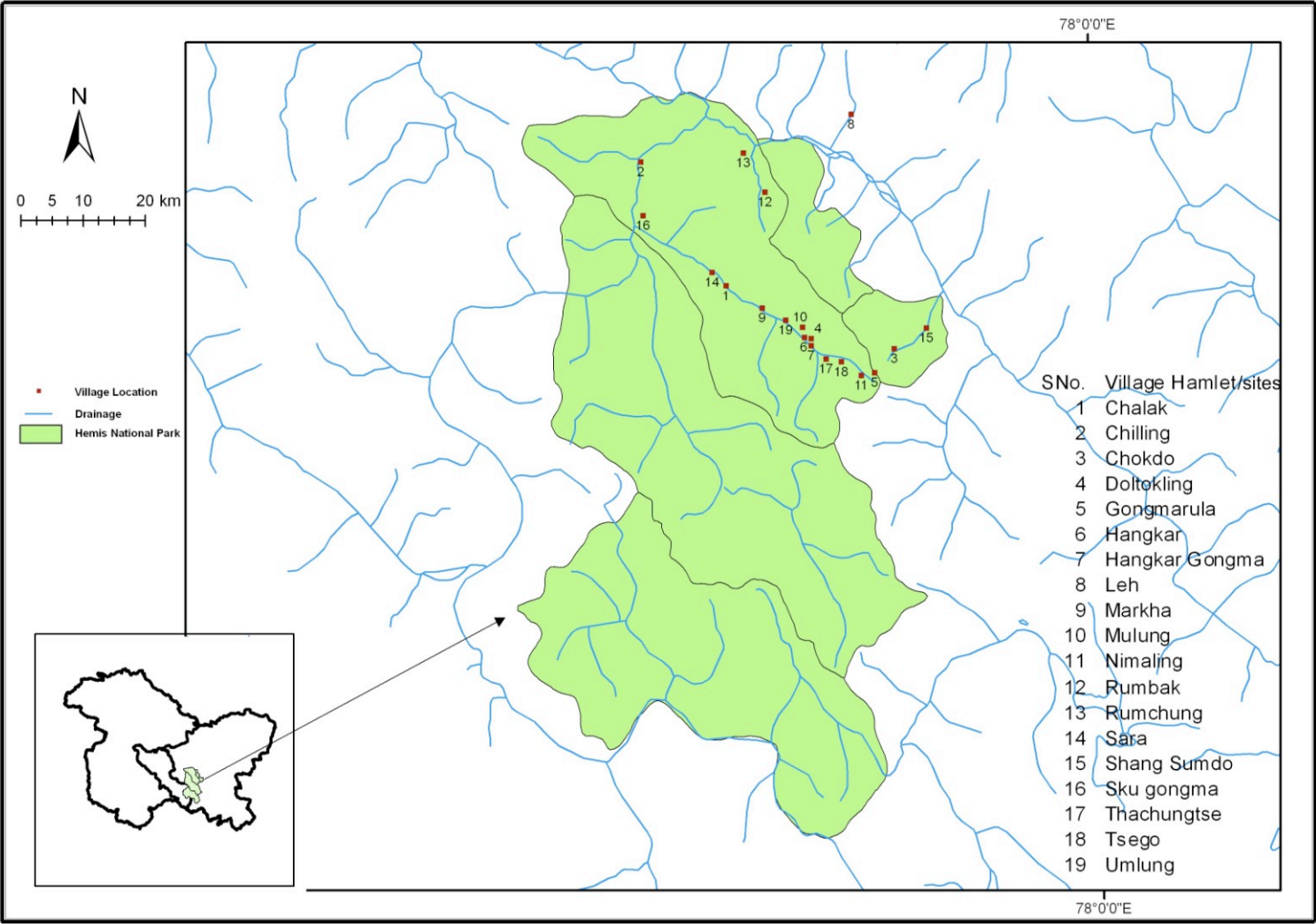
PLATE 1

2.2 INTENSIVE STUDY AREA - HEMIS NATIONAL PARK

2.2.1 Location

Hemis National Park (HNP), a representative landscape unit of the larger Ladakh landscape was chosen for intensive study. Hemis National Park was established, to the south of the Leh city ($34^{\circ}9.844'$ N and $77^{\circ}35.068'$ E) in the year 1981, through the intentional notification vide Government Order No. FST/20, dated 4 February 1981 and was initially named as 'Hemis High Altitude National Park'. The National Park, located at $33^{\circ}15'$ to $34^{\circ}20'$ N latitude and $75^{\circ}50'$ to $77^{\circ}45'$ E longitude (Figure 2.1), initially occupied an area of 3350 sq km (Anon. 2007). Final notification for the Hemis National Park was made on 19th March 1987, vide order SRO # 38, by the Government of J&K. Since then more area has been added to the national park, as a result the park now encompasses an area of 4750 sq km. The national park's altitude ranges from 3,200 m in northwest to 6,400 m above sea level at Stok kangri peak. Hemis monastery, an ancient and famous pilgrimage point for the Buddhist community gave the national park its name "Hemis". The park area encompasses the catchments of Markha, Rumbak, Sumdah and Chang chunmo streams, lying at the west bank of river Indus (Figure 2.1).

Figure 2.1: Location Map of Hemis National Park, Leh, Ladakh



2.2.2 Catchment area

HNP occupies a large part of the drainage basin of the lower Zaskar River, starting at the merger of Zaskar with the Markha uptill its confluence with the Indus river. Northern part of the park comprises of Sumdah Valley. This valley has south-east, orientation and meets the main Zaskar Valley. Markha valley and Rumbak valleys represent the southern sector of the park. The Markha valley has Northwest-Southeast orientation and is a side/tributary of the Zaskar Valley. While the Rumbak basin has eastwards orientation and meets the Indus Valley. Shang catchment area forms the south sector of the park and has Marchelung stream as its main drainage, which joins the Indus river (Anon. 2007).

2.2.3 Geology and edaphic characteristics

The Sumdah, Markha and Rumbak valleys are rough and rocky with rock and stones spread all over. These valleys are lined by steep mountain peaks, often reaching height beyond 5,000 m and extending up to 6,000 m. Slates, phyllites, schists, quartzites, crystalline limestones and dolomite are the main rock types found in the area. Tertiary and Mesozoic sedimentary formations define the geology of the HNP (Wadia 1978). Solar weathering of the exposed rocks on the mountain slopes provides exquisite colour to the hills and mountains.

Soil composition varies from coarse loam, sandy to skeletal. The valley bottoms typically are sandy clay in nature. Overall the soil has low carbon and nitrogen and is acidic, making them unsuitable for cultivation.

2.2.4 Ecological attributes

2.2.4.1 Climate

The area experiences extreme climatic conditions, which are observed in daily and seasonal variations of temperature. In summers, temperature ranges from 30° C under sun to 4 to 5° C under shade. The region receives little precipitation (approximately 160.5 mm/year as recorded at Leh), and that too mostly in form of snowfall that can happen anytime of the year. Temperatures far below zero degree centigrade (-15°C to -20°C) at night and average temperature of 0° C at day time causes the rivers to remain frozen during winters.

2.2.4.2 Forest types and vegetation

Alpine and steppe vegetation, represented by short trees and shrubs, dominates the vegetation in HNP. Alpine vegetation is restricted to the lesser areas of moist upper mountain slopes comprising of genera such as *Anemone*, *Gentiana*, *Thallictown*, *Lloydia*, *Veronica*, *Delphinum*, *Carex* and *Kobresia*. Steppe vegetation is found along the mountain slopes and open areas, which comprises the main landforms of the PA. Steppe vegetation is represented by *Caragana*, *Artemisia*, *Stachys*. Forests are absent in the HNP, though some trees of *Salix* spp., *Populus ciliata* and *P. nigra*, *Juniperus semiglobosa* are usually found in moist areas at the bank of streams (Plate 1).

Exiguous rangelands and herbaceous vegetation on hill sides, shrubs and lax forests form characteristic landscape feature of the Markha, Rumbak valleys, and thus makes them high altitude deserts.

Patches of dense mixed scrub (5-10 m high) of seabuckthorn (*Hippophae salicifolia*), willows (*Salix* spp.), myricaria (*Myricaria elegans*) and rose (*Rosa webbiana*) occupy 20% humid valley basins up to 3,500 m. Valley bottoms constitutes < 10% of the area of the National Park. Poplars (*Populus* spp.) are found to be cultivated in these valley bottoms at an altitude up to 3,700 m. As one progresses further from 3,500 m to 4,000 m, the height of this mixed scrub gradually decreases and is observed to be shorter than 5 m. This mixed scrub transforms into extensive patches of seabuck thorn (*H. salicifolia* and *H. rhamnoides*) at the valley bottoms, or monoculture of willows (*Salix* spp.), in the valleys. Beyond 4,000 m, seabuckthorn (*H. rhamnoides*) creates compact low lying (30 cm) patches, interspersed with *Myricaria squamosa*, growing as individuals *Rosa webbiana*, *Lonicera* spp., *Ephedra gerardiana* and *J. macropoda* are found to be scattered on hills up to 4,000 m, as individuals. At the altitude of 4,300-5,000 m, patchy occurrence of *Caragana* sp. is observed. Overall, 5% of the surface area of the park, is covered by shrubs about 15% area is occupied by graminaceous and herbaceous plants, thus making them the primary vegetation. Among graminaceous and herbaceous plants woundwort (*Stachys tibetica*), cinquefoils (*Potentilla* spp.), wormweeds (*Artemesia* spp.), *Bistorta* spp. and *Agrostis* spp. represents the dominant species. *Carex* spp. and *Kobresia* spp. representing the sedges dominate the meadows located at the valley between

4600 to 5100 m. On the physiognomic basis, vegetation of the HNP can be classified into four classes

- 1) Riverine Scrub: *Salix*-*Myricaria*-*Hippophae* scrub along the stream courses and banks.
- 2) Scrub-Steppe: *Artemisia* - *Caragana*, *Ephedra* - *Juniperus*, and *Lonicera* – *Rosa* occurring along the gentle slopes.
- 3) Herbaceous and grassy meadows: occurring along the valley bottoms in clayey soil predominantly having *Potentilla* - *Geranium*, *Festuca* – *Stipa*, *Carex* and *Kobresia*.
- 4) Alpine arid pastures: occurring at > 4800 m asl, supports limited vegetation cover, having *Draba*, *Rhodiola*, *Christolea* and *Saussurea* as characteristic species.

2.2.4.3 Faunal diversity

The HNP is a prime area for conservation of Snow Leopard (*Panthera uncia*). an endangered large carnivore belonging to the Eurasian Fauna from the Trans-Himalaya and the central Ladakh (Fox & Nurbu 1990).

Presence of 16 mammalian species, 73 bird species and 3 species of reptiles has been reported from the national park. Snow leopard (*Panthera uncia*) and the Tibetan Wolf (*Canis lupus chanko*) are the prime carnivore species of the region. Besides these carnivores evidence of presence of Lynx (*Lynx isabellina*), Wild dog (*Cuon alpinus langier*), Red fox (*Vulpus vulpus*) is reported from the region. Among ungulates, Siberian ibex (*Capra ibex*

siberica), Ladakh urial (*Ovis vignei vignei*), Bharal (*Pseudois nayaur*), Tibetan argali (*Ovis ammon hodgsoni*) are found in this region (Bhatnagar & Wangchuk 2001, Namgail 2001). High altitude pastures of the region supports the population of Himalayan marmot (*Marmota bobak*), mouse hare or pika (*Ochotona roylei*) and Himalayan Snowcock (*Tetraogallus himalayensis*). Golden Eagle (*Aquila chrysaetos*), Himalayan Griffon (*Gyps himalayensis*) and Bearded Vulture (*Gypaetus barbatus*) are the raptor species found in the park.

Table 2.2: Large mammals of Hemis National Park along with their conservation status

Name			IUCN category	Wildlife (Protection) Act 2002 (Schedule)
Scientific	Common	Local		
<i>Panthera uncia</i>	Snow leopard	Schaan	Endangered	I
<i>Canis lupus chanco</i>	Tibetan wolf	Shanghku	Vulnerable	I
<i>Lynx isabellina</i>	Lynx	Eee/Eeh	Near threatened	I
<i>Cuon alpinus langier</i>	Wild dog	Pharra	Endangered	II
<i>Capra ibex siberica</i>	Ibex	Skin	Vulnerable	I
<i>Ovis vignei vignei</i>	Ladakh urial	Shapo	Endangered	I
<i>Pseudois nayaur</i>	Bharal	Knapo	Low risk	I
<i>Ovis ammon hodgsoni</i>	Tibetan argali	-	Near threatened	I

2.2.5 Social attributes

2.2.5.1 Human landscape

Human habitations all along the HNP are found at the valley bottoms where there is ample water and shrubs to sustain human needs – crops and livestock. The Hemis National Park has five valleys – Sumda, Rumbak, Sku-Markha, Shang and Niri chu. There are twenty three village hamlets located

along these valleys, with human population of 1600 (Anon. 2007). The Sumda valley has four village hamlets – Chilling, Sumda do, Sumda chay and Sumda Chu. The Rumbak valley has four village hamlets – Rumchung, Zingchen, Rumbak and Yurutse. The Markha valley has seven village hamlets - Sku, Kaya, Shingo, Markha, Umlung, Doltokling and Hangkar. The Shang valley has three village hamlets – Chokdo, Kichan and Shang. The population of these villages is mainly agro-pastoralists. Due to heavy snow on mountain passes of Gandala (4,900 m) and Knogmarula (5,200 m), in winter these villages remain isolated from each other and also from the nearest town of Leh. The Zanskar river forms a barrier during the most of the year due to lack of foot bridges over its length and can be crossed only in winters when it is frozen. The inhabitants of this region are Buddhist. The village commons or the village woodlots called “*rong*” are inside the park boundaries and these are usually located at the valley bottoms, where plantation is done by the villagers, NGOs and also by the Government agencies.

2.2.5.2 *Economic structure*

The Ladakhi population residing within the park boundaries have traditionally been following agro-pastoralism. Under the influence of tourism activities within the HNP, tourism also now contributes to the economy of local people, especially those living along the favourite trekking trails, such as Markha, Rumbak. The pack animals form the base of tourism, which has resulted in shift in the livestock number and types and hence the area has observed a decrease in the number of yaks and subsequent enlargement of the individual grazers flock size consisting of goats, sheep and horses.

2.2.5.3 *Human-wildlife interaction*

The national park had permanent human settlements within its boundaries at the time of notification and hence has an ancient history of local people and wildlife interaction. The area being rich in faunal assemblage, since British occupation of India, has attracted the hunters and nature lovers. Rumbak and Shang valleys have been the popular blue sheep hunting location for the British and the Indian army, as illustrated through the paintings by Ward (1924). Till 1980, the HNP and adjoining areas were managed as Game sanctuary with regulated hunting. Hunting permits were revoked in 1987, after the final notification for the National Park. Due to close interspersed human habitation and human land use with the wildlife habitat, incidences of human-wildlife interactions have been reported from the area and which has resulted in retaliatory killing by the local people. Bhatnagar et al. (1999) reported 12% of livestock predated by the carnivores along with some incidences of crop loss as a result of browsing by wild ungulates.

Tourism influx in recent decade has put pressure on the resources of the National Park. The Markha valley is one of the most favoured trekking circuits among the adventure tourists. Overgrazing caused by the pack animals of the tour operators is visible along the trekking trail of Markha valley (Geneletti & Dawa 2009). Though, at the other hand tourism has improved economy of the local people, through community based initiatives, such as Homestays and Parachute café. The national park has resources of use for both the wildlife and the local community however the problem arises when

there is competition over spatio-temporal use of resources. This situation gets aggravated in case of limited resources, where survival is dependent on access to these. While developmental agencies focus on human welfare, the survival of wild flora and fauna is severely undermined by the narrow focus of development approach for human welfare. Since, residing inside the protected area, the local people often complaint of poor access to markets, health and education facility due to lack of roads. These casual complaints turn into negative attitude when these people lose their income sources (livestock and crops) due to wildlife. Under this scenario the main task of the park management is to maintain balance the human aspirations for economic gains and the need of pristine and undisturbed animal habitat.



3.1 INTRODUCTION

The challenge with the study of human-wildlife interaction remains with the fact that it requires an understanding of multiple inter-related aspects of human and wildlife ecology. To understand the situation of human-wildlife existence, multiple variables need to be observed and studied, depending on which the situation of overlap of human and wildlife utilization can be categorized as a situation of “co-existence”, “competition”, or “conflict”. Social research methods include a wide array of tools and techniques, all of which can be used in combination or singly for the purpose of data collection (Bernard 1995). Social research methods can be qualitative as well as quantitative, depending on the objective of the study. Transect walks, participant observations, focus group discussions, semi-structured interviews, structured questionnaire survey are some of the commonly used methods, some of which are used for the present study, as well and are discussed in details in following sections and relevant chapters.

The framework for the study, represented in figure 3.1 depicts the research approach used for the purpose of understanding human-wildlife interaction in the HNP, Leh-Ladakh.

Figure 3.1 Framework for the study

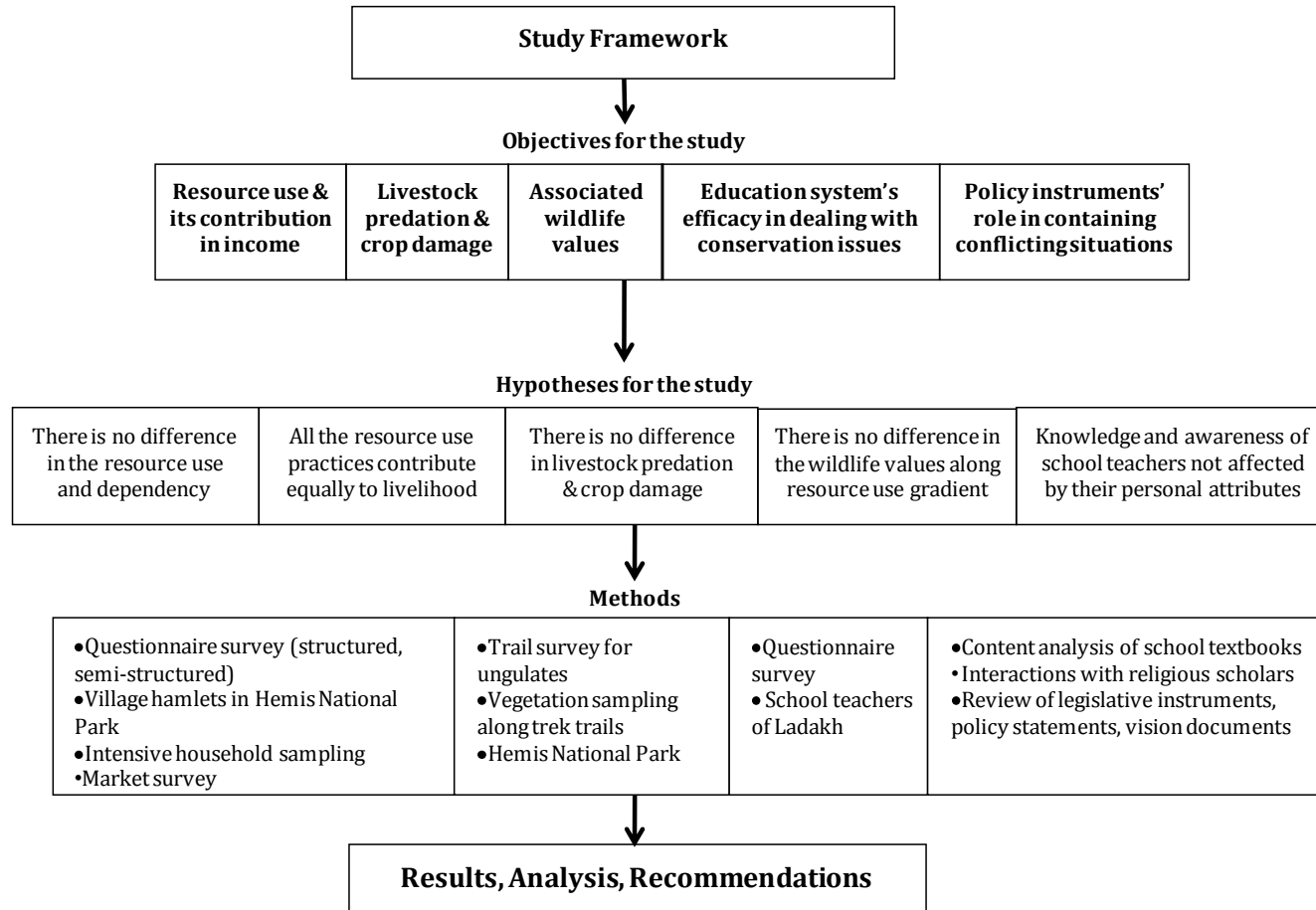


Table 3.1: Summary of methods adopted for this study

Objectives	Variables	Instrument	Sample population	References
Dependency of people on the natural resources	Income sources	Questionnaire survey and personal observations	Residents of HNP	Ashley et al. (1999) Badola (1997)
	Resource uses	Questionnaire survey and personal observations	Residents of HNP	Ashley et al. (1999) Badola (1997)
	Non-monetary dependency	Questionnaire survey and personal observations	Residents of HNP	Ashley et al. (1999) Badola (1997)
Evaluate the pattern of conflicts and benefits	Livestock depredation	Questionnaire survey and personal observations	Residents of HNP	Mishra (1997a)
	Crop damage	Questionnaire survey and personal observations	Residents of HNP	Naughton-Treves (1998)
	Monetary value of livestock and crop	Market survey	Key informants	Mishra (1997a)
	Monetary benefits accruing from resource use	Questionnaire survey and personal observations	Residents of HNP	Wunder (2000)
Impact of resource use on wildlife value	Wildlife abundance	Secondary sources and personal observations	Trek routes and villages in HNP	Mishra (1997b)
	Vegetation characteristics	Secondary sources and personal observations	Trek routes and villages in HNP	Mishra (1997b), Kent & Coker (1992)
Examination of education system in their ability to address conservation issues	Formal education systems	Content analysis	Class V to VIII text books of J&K State Board of School Education	Burrus-Bammel et al. (1988), Nytell (2003)
	Religio-cultural values	Questionnaire survey and personal observations	School teachers of Leh and Kargil districts	Cutter & Smith (2001)
		Interaction with religious teachers, scholars; literature review	Religious scholars and monks of Leh	Fowler (1993)
Policy assessment for their effectiveness to address conservation and development	Policy instruments	J&K Wildlife Protection Act (1978); J&K Forest Conservation Act; J&K Kahcharai Act 2011; J&K State Forest Policy (2010); LAHDC Vision document (2005); review of literature		Badola et al. (2011)

3.2 TOOLS AND TECHNIQUES

Focus group interviews yield insights about the issues and ways in which problems may be ranked, Bernard (1995). The numbers of focus groups in the study area depend on the social structure and demographic conditions. Each focus group had 6-8 people, which enabled the researcher to gain an understanding of the scenarios of “human-wildlife interaction”. The *focus group interviews/discussions* helped in drafting a set of questions. The questionnaire thus generated was subject to pre-testing (Fowler 1993).

Semi-structured interviews aimed at obtaining secondary data from officials of different agencies involved in various developmental activities as *Semi-structured interviews* is best in situations where interviewer won't get more than one chance to interview someone (Bernard 1995). Information from *Semi-structured interviews* helped in strengthening interview schedule and it also provided insights to the policies adopted by the government over a time period. Semi-structured interviews were held with the government officials, village elders, religio-cultural scholars and teachers.

Structured survey interviews were used for obtaining information on socio-economic set up, livelihood options, resource use and for quantification and measurement of perceptions and impacts of “human-animal interaction” through livestock predation and crop damage at the household level. The data thus obtained complemented the detailed, in-depth material acquired through semi-structured interviews and focus group discussions. Different sets of questionnaire were framed to obtain information at individual household level

(with respect to resource usage, income sources, losses associated with livelihood options due to wildlife); school teachers' knowledge and attitude on conservation and wildlife.

Trail survey method was adopted for estimating abundance of wild ungulates in the study area (Bhatnagar 1997; Johnsingh et al. 1999). Eight trails, of length from 2 to 4 km were monitored twice during 2006. The trails were walked at a uniform pace and on spotting the mammals (with eyes or using 7x40 binoculars) species, number of individuals, group size, activity (feeding, foraging, resting, moving), aspect, GPS location of the sighting, altitude, approximate distance from human habitation were recorded for each sighting.

For vegetation analysis, 100 sample plots were laid across the trails in the Rumbak and Markha valleys. The plots were laid out at a distance of 0 to more than 5 km from 10 permanent human habitations (village hamlets), (Fernandez-Gimenez & Allen-Diaz 2001, Sasaki et al. 2005). The plots were laid on both sides of the trails followed by the villagers for grazing and also used by the tourists for trekking. The distance between two plots was 500 m. At each location a plot of size 5 x 5 m for shrubs was laid and within this plot a plot of to 1 x 1 m for herbs was laid. Data for each plot consisted of vegetation cover, GPS location, approximate distance from human habitation, aspect, substrate type and species number following Kent & Coker (1992). Plants were identified in field or taken to the High Altitude Defence Laboratory, Leh and Wildlife Institute of India for identification.

Relative density, frequency, Shannon-Wiener Index (D) and Simpson's evenness index (H) were calculated using the following formulas.

$$\text{Density} = \frac{\text{Total number of individuals of a species}}{\text{Total number of quadrants studied}}$$

$$\text{Frequency} = \frac{\text{Number of quadrants in which the species occurred} \times 100}{\text{Total number of quadrants studied}}$$

$$\text{Abundance} = \frac{\text{Total number of individuals of a species in all quadrants}}{\text{Total number of quadrants in which species occurred}}$$

Shannon-Wiener Index

$$H' = - \sum [(n_i / N) * \ln(n_i / N)]$$

Where, H' = Shannon index of diversity
 n_i = number of individuals or amount (density or abundance) of each species (the *i*th species)
 N = total number of individuals or amount (density or abundance) for the site
 $\ln$ = the natural log of the number

Simpson (1949) index of evenness:

$$D = \sum n(n-1) / N(N-1)$$

Where, D = Simpson index of dominance
 n_i = number of individuals or amount of each species (i.e., the number of individuals of the *i*th species)
 N = total number of individuals for the site

Content Analysis of text books and review of the policy documents was done for examining the efficacy of the formal education systems and

legislative measures, respectively, to deal with conservation issues and human-wildlife interaction. Content analysis involves documentary research of any form of physical communication, viz. journals, films, books, articles (Burrus-Bammel et al. 1988) and is often used for measuring certain phenomenon in text (Nytell 2003).

3.3 STUDY DESIGN AND DATA COLLECTION

The fieldwork for the present study commenced in July 2005 and continued up to November 2006. In this period, approximately one and half years of field data collection relevant to different objectives of the study was undertaken. In the initial phase of the study, a detailed review of the literature on human wildlife interaction from India and across the globe was carried out.

After initial visit to the Ladakh region in June 2005, HNP was identified as an intensive study area for observing the human-wildlife interaction. Necessary entry permits were obtained from the Jammu & Kashmir Wildlife Protection Department to visit the HNP and carry out field work. Special permits were obtained from the forest department for collecting samples from both wild and captive populations. Offices of the LAHDC, Animal Husbandry department, Education department and Revenue department were visited to obtain demographic information. Subsequently, field assistants were identified. Visits were made to the human settlements inside the park to obtain information on the resource use, threats from the wild animals, benefits received from tourism. Vegetation sampling was carried out along the trek trails in the Park to examine the vegetation character along the human

resource use gradient. Trek trails were also used for observing the presence of the wildlife. To obtain the information on efficacy of education system in dealing conservation issues, questionnaire survey was carried out among the school-teachers in Leh and Kargil districts (Figure 6.1). Table 3.1 provides a summary of methods adopted for the present study.

Objective 1: Study the pattern of resource use and its contribution to livelihood of local communities.

Data collection was done in two stages. As part of the first and preliminary stage, data on village parameters, their location, number of livestock, presence of instances of livestock depredation, crop damage, accessibility to resources, presence of wildlife, village maps were gathered from the government offices of LAHDC (Ladakh Autonomous Hill Development Council), viz., Tehsildar's office, Sheep and Animal Husbandry Department, Planning and development department, Directorate of Economics and Statistics, Jammu & Kashmir Wildlife Protection Department (J&K WLPD). After identification of the villages for sampling, village headmen were interviewed to obtain basic information on the villages.

In the second and final stage of data collection, households within the villages were interviewed with the help of pre-designed and pre-tested questionnaire format. To obtain pattern of resource use at village and household level, primary data was collected from 72.5% (N = 108) households in the four village clusters, viz. Chilling, Rumbak, Shang and Markha, in the HNP. At least one member from each family, above 18 years was interviewed. The information was recorded on the questionnaire sheet

and any additional information provided during the interview was also noted down.

A set of *Semi-structured, structured, un-structured* and *focus group* interviews, having open-ended and close-ended questions were used. *Structured* and *un-structured survey interviews* (Fowler 1993) with the local community were done for obtaining information on socio-economic set up, the available livelihood options available and their interactions with wildlife.

Objective 2: Evaluate the pattern of conflicts arising from resource use practices by the local communities and its impact on wildlife values

Both secondary and primary data were used for obtaining information on the pattern of conflicts arising from resource use practices. Previous studies, forest and wildlife department's records were the secondary source of information. To obtain patterns of conflict at village and household level primary data was collected from 108 households, residing in the four village clusters, with the aid of structured questionnaire survey instrument. Information and data on incidence of livestock loss or crop damage by the wild animals, sensitive areas of conflict, temporal and age, sex and species-specific data, compensation schemes etc. was obtained through *Semi-structured, structured, un-structured* and *focus group* interviews.

For finding the prevalence of wildlife along human-use gradient, both secondary and primary sources were used. Since, *Pseudois nayaur* (Blue sheep) is the most abundantly and widely distributed wildlife species in the HNP, transects (1-4 km) were walked along the valley bottoms and trek trails to know its density. Vegetation sampling in plot size of 1 x 1m for herbs and grasses and 5 x 5m for shrubs (N=100 plots) was done along the trek trails.

Objective 3: Examine the existing education systems and religio-cultural values in their ability to address the conservation issues of the region

To examine how conservation issues are dealt in by the formal and non-formal education systems, content analysis of the science and geography school text books and syllabus of class V to VIII for the J&K State Board of School Education (J&KBOSE) was carried out. Government school teachers were interviewed (N=277), in Leh and Kargil districts to assess knowledge and attitude of teachers on conservation issues. Interviews with religious scholars (N=30) provided information on the religio-cultural teaching practices dealing with conservation issues in the region.

Objective 4: Examine the existing policy instruments and suggest improvement to minimize such conflicts.

The analysis of conservation instruments initially reviews the status and condition of legislative framework and management practices *vis-a-vis* local people's, dependence on natural resources and aspects of human-wildlife

interactions, in the HNP through extensive literature surveys and analysis of policy documents. Subsequently, the existing policy and legislative documents were reviewed to examine whether the policy instruments recognize people's dependence on natural resources and ensure equitable access to resources; support adaptive management to address the conflicts resulting from human-wildlife interactions, by clarifying property rights, respecting customary rights, allowing compensation or incentive based mechanisms, promoting stakeholder participation, encouraging local institutions with support from higher levels. The impacts of sectoral policies acts and rules on human-wildlife interactions, particularly the dependent local communities was critically examined. The framework hence identifies the gaps in the policy and suggests future directions taking cognizance of current status and trends in human-wildlife interaction.

3.4 DATA PREPARATION AND ANALYSIS

Qualitative data obtained through *semi-structured*, *structured*, *unstructured* was coded for the categorical data where needed and entered into MS Excel format. Each field was termed as a variable, for e.g. village cluster name, respondent's name, sex age, number of family members, income. "No response" or "not applicable" were left as blank cells or as "0" according to the variable need. Coding of the variables has been discussed in detail in relevant chapters. The coded data was checked for gaps and wrong entry. The final data sheet was used for univariate analysis and distribution of response using SPSS 16.0.

The data sheet was further analyzed using descriptive (mean, sum, percentage, frequency), bivariate and multivariate analysis, using correlation and one-way ANOVA, to determine the relation between the variables. Detailed data analysis is discussed in the individual chapters. Results obtained thus are represented in tabular and graphical form, in the consecutive chapters.

3.5 LIMITATIONS

Though 100% sampling of the households was attempted, but either due to non-availability of the senior member of the household or unwillingness to participate in the study information from 72.5% of the households only could be gathered. Sometimes the loss of livestock and crop damage could not be assessed on the spot due to limitations of the terrain and due to widely spread nature of fields. Instead relying on respondents' estimation of crop loss, the incidence of crop damage (yes/no responses) due to ungulates and natural factors such as rain-slides was noted. Since, Blue Sheep was the only widely distributed wildlife in the study area, only its presence was recorded.



THE HUMAN LANDSCAPE, RESOURCE USE AND ASSOCIATED WILDLIFE VALUES

4.1 INTRODUCTION

The study of interactions between human, plants, animals, and the space that they live in is essential for understanding the bio-physical phenomenon associated with integrated ecosystem approach and its management (Folke et al. 2005). As pointed by Grove & Burch (1997) and Folke et al. (2005) the physical, chemical and biological processes of environment affect the human species while the biological and social characteristics of the humans (though shaped by evolution) affects their immediate environment. In the context of tropical and sub-tropical countries, where the local populations are dependent on the resources for meeting their daily subsistence needs, the preservationist approach followed for conservation of the natural resources are ineffective in either conserving the natural resources and or meeting the primary needs of the local populace. It is widely known that conflicts between the agenda of the 'resource users' and the 'resource conservers' are detrimental to the conservation efforts (Woodroffe et al. 2005, West et al. 2006). Imposing PAs on the resource dependent communities also has a large number of negative consequences. These conflicts and associated consequences are mainly due to lack of understanding of the locale specific needs and aspirations of the local populace and lack of understanding of the people-resource interaction (Badola et al. 2012). In the pretext of omnipresent people-park conflicts in the

third world the 'species oriented' approach is now being seen in a broader perspective, i.e. 'ecosystem level approach'. The study of human landscape approach involves - "human behaviour within ecological systems" (Risser 1987); "human inhabited and cultivated land uses in an ecosystem" (Forman & Godron 1986) and "landscape examination at human scales" (Wiens 1992). This approach, involves the study of social forces, economic status and environmental quality that is being affected due to human activities (Silori & Mishra 1996) and has been applied to the studies of PAs in the recent decades (Machlis & Tinchell 1985, Machlis 1989, Machlis 1992, Saberwal & Kothari 1996, Badola 1997, Chandola 2001, Semwal 2006). Such interdisciplinary approach of the merging social, economic and environmental forces to achieve the goal of conservation has more importance in a country like India where the use of natural resources has been the part of traditions and culture of the majority of the rural population (Panwar 1990, Leach 1991, Lynch 1992, Badola 1999, Hussain & Badola 2010) and is also influenced by the economy, and the policies, which has been put forth as "culture structures landscapes and landscapes inculcate culture" by Nassauer (1995). Understanding of the local social and economic systems, along with the local and regional policies may help in identification of alternatives to the resources, it could predict availability and consumption pattern and can also project rate of exploitation of natural resources (Badola 1997). Very often, non-timber forest resources are critical to many aspects of daily lives of forest dependent populations, including house construction, food security, health and cultural ceremonies and as a constant source of income (Cocksedge 2001). This is particularly so in the remote areas, where people are distant from major marketing centres, educational facilities and income-earning opportunities. Dependence on the natural resources can be due to lack of alternatives, lack of

education and awareness and it could also be due to habit, called habitual dependency and it could be cultural dependency (Badola 1997). More recently, Timko et al. (2010) listed five socio-economic factors affecting dependency level in African sub-continent's context, which are: access to forests and markets, wealth status, gender, education and seasonality. These factors also determine resource dependency anywhere else in the developing nations. Identification of the factors affecting resource dependency is vital information for formulating community based conservation and management plans. While on the other hand, it is equally important to know the effect of human activities on natural vegetation of an area, as human activities are known to shape the ecosystem around them (Folke et al. 2005, MA 2005) often questioning ecological sustainability of human use of resources (van Schaik et al. 1997, Sagar & Singh 2004, Kumar & Shahabuddin 2005, Sahu et al. 2008). Impact of livestock grazing on rangeland ecosystem has often lead to soil erosion due to loss or change in vegetation cover (Kala et al. 2002, McIntyre et al. 2003), increased soil compactness and inability of such soils to hold moisture (Sahani & Behera 2001, Mehta et al. 2008). Livestock are also known to compete with the wild ungulates for resources, often driving them to the non-optimal areas (Mishra et al. 2004, Ogutu et al. 2005, Namgail et al. 2007a, Shreshta & Wegge 2008).

This chapter thus aims to assess the dependency of local communities living in the HNP on the natural resources of the area; and the factors, *viz.*, access to forests and markets, wealth status, gender, education and seasonality that determine the type and level of dependency. The chapter further aims to explore the wildlife values along the resource use gradient in the study area, using indicators such as vegetation structure, diversity and ungulate population.

4.2 METHODS

4.2.1 Resource use and dependency

Qualitative and quantitative data was gathered for gaining insight of the human landscape, and the resource use pattern of the local community living inside the HNP. Secondary data on human population, livestock and land resources at block and village levels was procured from the Directorate of Economics and Statistics, Leh. Village administration maps, locally known as “*Latha* maps” or the “revenue maps” were obtained through the office of the Land Revenue Department, Ladakh Autonomous Hill Development Council (LAHDC). These maps provided the land use classifications for the village hamlets.

Primary data was collected with the aid of questionnaire, information sheets. Village history and information on present resources was sought through focus group discussions. Resource mapping was done with the help of focus group of villagers following (Nemarundwe & Richards 2002), to identify areas utilized for fuel, fodder, timber, medicinal plants, and vegetable collection. Random and unstructured talks with village elders provided quantitative information on culture and associated resource use, in accordance with the Buddhist religion (Bernard 1995).

Pre-formatted questionnaire was used for obtaining quantitative information on human resources, agriculture practices, livestock tending practices, income sources, resource collection and usage (Badola 1997). For collection of the above information the researcher visited each and every

household. Interviews were conducted either in the houses or the fields. Though 100% sampling was aimed, but due to lack of availability of family members, or due to unwillingness of the households to participate in the study 72.5% of the total households were finally sampled.

From each of the households, the number of total family members, number of children studying, their place of education, number of people engaged in various income generation activities, number of family members having permanent source of employment living outside the HNP, annual income from each income source was obtained.

Total family income was obtained by adding all sources of income for a household. Thus,

$$\text{Annual Income per household} = \Sigma \text{Income from (Livestock + Remittances + Non-farm + Tourism)}$$

$$\text{Actual HH members living in HNP} = (\text{HH members reported}) - (\text{HH members studying outside HNP} + \text{HH members working outside the HNP with permanent jobs})$$

$$\text{Percent of tourism income to total income} = (\text{Income from resource use/ total income}) \times 100$$

Descriptive statistics (mean, percentage, standard deviation) was used for summarizing the results. Chi-sq., one-way ANOVA, Kruskal-Wallis and Cronbach's alpha statistics were carried out using SPSS 16.0, to discern trends and relationship among various variables.

4.2.2 Wildlife values

To examine distribution and status of wild mammals and vegetation in the study areas, both secondary and primary sources were utilized. The secondary sources provided information on status and distribution of wild mammals in the study area and helped in identifying the mammal species to be surveyed in the study area.

For mammal survey, trail survey method was adopted (Bhatnagar 1997, Johnsingh et al. 1999). Eight trails, of length from 2 to 4 km were monitored twice during 2006. The trails were walked at a uniform pace and on spotting the mammal (with eyes or using 7x40 binoculars) the species, number of individuals, group size, activity (feeding, foraging, resting, moving), aspect, GPS location of the sighting, altitude, approximate distance from human habitation were recorded for each sighting. Encounter rates was calculated by dividing the number of individuals sighted on each trails by the length of the trail (Chanchani et al. 2010).

For vegetation analysis, 100 sample plots were laid across the trails in the Rumbak and Markha valleys. The plots were laid out at a distance of 0 to more than 5 km from 10 permanent human habitations (village hamlets), (Fernandez-Gimenez & Allen-Diaz 2001, Sasaki et al. 2005). The plots were laid on both sides of the trails followed by the villagers for livestock grazing and also used by the tourists for trekking. The distance between two plots was 500 m. At each location a plot of size 5 x 5 m for shrubs was laid and within this plot a plot of to 1 x 1 m for herbs was laid. Data for each plot consisted of

vegetation cover, GPS location, approximate distance from human habitation, aspect, substrate type and species number following Kent & Coker (1992). Plants were identified in field or taken to the High Altitude Defence Laboratory, Leh and Wildlife Institute of India for identification.

Relative density, frequency, Shannon-Wiener Index (D) and Simpson's evenness index (H) were calculated using the following formulas.

$$\text{Density} = \frac{\text{Total number of individuals of a species}}{\text{Total number of quadrants studied}}$$

$$\text{Frequency} = \frac{\text{Number of quadrants in which the species occurred}}{\text{Total number of quadrants studied}} \times 100$$

$$\text{Abundance} = \frac{\text{Total number of individuals of a species in all quadrants}}{\text{Total number of quadrants in which species occurred}}$$

Shannon-Wiener Index

$$H' = - \sum [(n_i / N) * \ln(n_i / N)]$$

Where, H' = Shannon index of diversity
 n_i = number of individuals or amount (density or abundance) of each species (the *i*th species)
 N = total number of individuals or amount (density or abundance) for the site
 $\ln$ = the natural log of the number

Simpson (1949) index of evenness:

$$D = \sum n(n-1) / N(N-1)$$

Where, D = Simpson index of dominance
 n_i = number of individuals or amount of each species (i.e., the number of individuals of the *i*th species)
 N = total number of individuals for the site

4.3 RESULTS

4.3.1 Village settings - location, habitation characteristics

Administratively, there are four village clusters, located in the Sumda, Rumbak, Sku-Markha and Shang valleys, inside HNP boundary (Table 4.1). These village clusters comprises small and scattered village hamlets (settlement), often comprising just two or three households (Table 4.2). The Chilling-Sumda village cluster is located in the Sumda valley, on the eastern bank of river Zanskar. This village cluster has four hamlets having 39 households. The Rumbak valley located in the southern sector of the park has four hamlets, with officially noted 37 households. Sku-Markha valley, also located in the southern sector is the biggest valley in the HNP as it has the largest catchment area, more number of village hamlets and more number of total households (61) as compared to the other three valleys. Shang valley is located in the eastern sector of the park and has three village hamlets with 50 households. Huge discrepancy was observed in the number of households as per the official records and the number of active households, as per the interviews with the locals (Table 4.1).

Most of the hamlets were located near water source, usually the streams and small rivers in the valley. Agriculture fields occupy the valley bottoms at or near the settlements and the woodlots (*rongs*) occupy the valley bottoms away from the settlements. The village houses were built in typical Ladakhi style, using mud, dung, stones and wood, modern construction using cement and bricks, was absent in the region. The people living inside the HNP have traditionally been using summer and winter pastures located inside the

park boundary. For the people living in the Markha valley or the Sku-Kaya village cluster, Nimaling or Thachungtse is the main summer pasture. The pastures of Nimaling and Thachungtse are also used by the relatives of Sku-Markha villagers living in villages outside the HNP. Besides, there are several small grazing grounds within one day's of walk from the village hamlets.

Table 4.1: Administrative setup of the villages in HNP, Ladakh

Village cluster	Block ^a	Panchayat ^a	Irrigated land (acres) ^a	No. of Households		Total Population
				a	b	
Chiling-Sumda	Leh	Rumbak	64	39	34	230
Rumbak	Leh	Rumbak	93	37	16	246
Sku-Markha	Leh	Rumbak	151	61	53	427
Shang	Kharu	Rumbak	93	50	46	242
TOTAL			401	187	149	1145

Source: ^aDistrict Statistical Handbook (LAHDC, 2001); ^bThis study

Table 4.2: Characteristics of villages located in HNP, Ladakh

Village cluster	Village hamlet	Number of Households	Latitude	Longitude	Altitude (m)	Distance from road (km)^a	Primary school^a	Middle school^a	PHC^a
Chiling-Sumda	Chilling	6	34°02'20.04"	77°12'07.63"	3195	0	Yes	No	Yes
	Sumda do	8	34°06'05.58"	77°12'54.71"	3178	0	Yes	No	No
	Sumada Chay	8	34°07'01.36"	77°11'10.64"	3475	5	Yes	No	No
	Sumda chung	12	34°07'59.84"	77°09'02.01"	3879	5	Yes	No	No
Rumbak	Rumchung & Zingchen	4	34°06'43.27"	77°23'45.78"	3440	0	No	No	No
	Rumbak	10	34°03'17.60"	77°25'57.93"	4055	8	Closed	No	Yes
	Shingo	2	34°01'40.15"	77°18'17.46"	4125	16	No	No	No
Sku-Markha	Sku	9	33°58'53.57"	77°16'08.47"	3351	2	Yes	No	Yes
	Kaya	9	33°59'55.75"	77°13'48.46"	3306	4	Yes	No	Yes
	Markha	20	33°53'13.23"	77°25'30.50"	3793	17	Yes	Yes	Yes
	Umlung	3	33°52'08.54"	77°27'54.82"	3872	25	Yes	No	No
	Doltokloing	5	33°50'29.57"	77°30'34.45"	4072	27	Yes	No	No
	Hangkar	7	33°50'37.10"	77°29'52.91"	3978	29	Yes	No	No
Shang	Chokdo	11	33°49'29.71"	77°39'12.77"	4136	13	Yes	No	No
	Shang	35	33°51'15.55"	77°42'33.84"	3687	0	Yes	Yes	Yes

Source: ^aDistrict Statistical Handbook (LAHDC, 2001)

4.3.2 Access to amenities/resources

4.3.2.1 Roads, PHC, market

Chilling-Sumda and Shang are located near metalled roads, while Markha village cluster was located farthest from the metalled road (25 km). The villages along the Sku-Markha and Rumbak are accessible by foot only. For the residents of the Rumbak village cluster it takes about 2-3 hours to one day to reach metalled road. Whereas for the residents of Markha cluster it takes, 6 to 7 hours to reach metalled road. Most of the villages are located on the trek route and have direct or indirect interactions with the tourists. Fair-weather roads provide access to the hamlets of Zingchen and Rumchung in Rumbak valley and Chokdo in Shang valley. Primary schools are present in all the four valleys (Table 4.2). Middle school was present only in Markha. In Rumbak the primary school has been closed, as the residents send their children to the schools in the Leh city. To avail medical, higher education and market facility the villagers have to travel to Leh. Springs are the only source of fresh water, which is used for domestic and agriculture purposes. Agriculture crop residues form the local source of fodder for the stall fed livestock. Dry crop residues stored by individual families forms the main fodder source during winter months. Locally collected livestock dung, dried shrubs and LPG cylinders from Leh constitute the energy source for cooking and warming.

4.3.2.2 Energy sources and amenities

Main source of electricity for the entire study area was solar since most of the households (73.15%) had solar panels, which were distributed by the Rural Department of the LAHDC. Shang village hamlet, had electricity transmission lines due to its location near the hydro-electric power project of Leh, but heavy rains in the month of June-July 2006 damaged the poles and electricity supply to the village was cut off temporarily during the study period. The villagers in this village were also supplied with solar lantern, and most of the respondent reported them not to be in working condition (Figure 4.1).

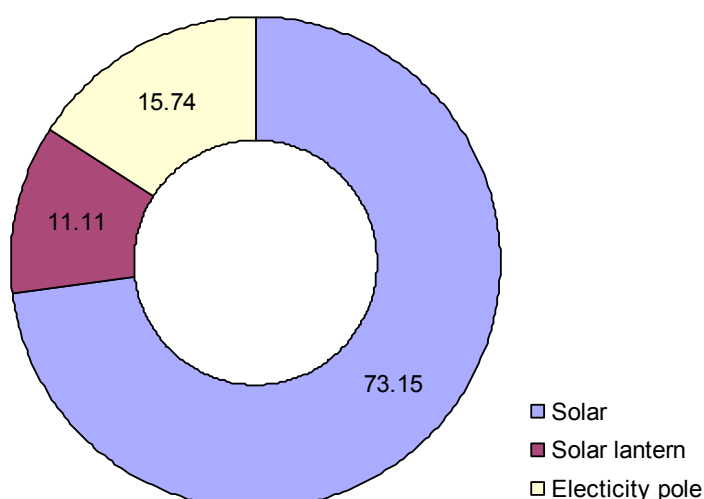


Figure 4.1: Source of electricity in the village hamlets of HNP, Ladakh

LPG along with the fuel wood and the livestock manure formed the source of energy for the entire study area. More than half of the households (63%) were found to be using LPG. Annual use of LPG varied from 15 days to 6 months, depending on the family size, and use of other fuel. Of the various luxury amenities radio, music system and television were owned by 76.8%, 33.3% and 22.2% respectively. It was observed that those households who owned the music system were also the houses owning a restaurant or the

individual camping sites. Only 3.7 percent household owned the Direct to Home satellite service (DTH) for television channels.

Table 4.3: Modern amenities available with the resident population of HNP, Ladakh (n = 108)

Amenities	Yes	No
LPG	68 (63)	40 (37)
Music system	36 (33.3)	72 (66.7)
Radio	83 (76.8)	25 (23.1)
TV	24 (22.2)	84 (77.8)
DTH	4 (3.7)	104 (96.3)

Figures in parentheses represent percentage

4.3.3 Agriculture pattern

The respondents reported approximately 216 acres of land under agriculture, which was irrigated through the village canals. Data on irrigated land from the tehsil office reports 401 acres of irrigated area. Local land measurement unit is *Kanals* and $\underline{c}$ 8 *Kanals* make one acre. The agriculture fields are small and scattered all along the valley bottoms. Individual household was owned an average of 2.05 ± 1.7 acres agriculture land. Significant difference was observed in the mean landholding pattern of the four village clusters [$F(3,104) = 18.96$, $p \leq 0.001$], with highest mean landholding recorded for Rumbak valley 4.26 ± 2.4 acres and lowest for Shang at 1.01 ± 0.51 acres.

Irrigation for the fields was provided by the main cemented canal passing through the village, which bifurcated into small *kutchra* feeder canals supplying water to the fields during sowing season. Due to short growing season there is little diversity of food grains. Wheat, barley and pea are the major crops of the region. Varieties of these three main crops can be found within the villages. Due to inaccessibility to the metalled road and small, scattered fields mechanized farming is absent in the region. Horses, donkey and dzo are used for agricultural purposes (Plate 2.a). In village hamlets located near the road head, small tractors and machines are now used for harvesting (Plate 2.b).

Onset of spring (May-June) embarks the agriculture season, which starts with preparation of the field, through ploughing, tilling and manuring. Barley and pea are grown at village hamlets located in higher altitudes. Whereas, village hamlets located at lower altitude were found to be growing wheat, alternating with barley. Pea and mustard crops are sometimes grown in combination with barley and wheat. Crop is harvested by September and the hay left in the field is stored as fodder to be used during winters (Plate 4.a). Seeds sown are usually the local variety, which are either from previous years' harvest or are brought from the government's store. Both male and female members of the household participate in agriculture activities related to labour intensive work of sowing and harvesting. Women members of the family are mainly responsible for other intermediate activities, such as weeding, watering. Overlap of agriculture work with tourism season keeps male members engaged in tourism related works. Crop grown fulfils the

subsistence and dietary requirements of the local people. Few leafy vegetables are grown in small quantity for self use only. Excess of vegetables (such as pea) is dried for use in winter months. In winter, some villagers bring herbs from pasturelands to be used as vegetable. In absence of many choices for food, the barley, wheat and pea grown here are used in multiple ways. The barely flour is used for making flat breads; flour of roasted barley is used for making *tsampa*, and other forms of local food (eaten with curd, or salt tea); barely seeds are used in making local beer (*Tchang*). Almost half of the residents living in the region practice food grain barter (Figure 4.2). The people living in and near Leh city bring food grains from the study area and in return provide services and or other food grains.

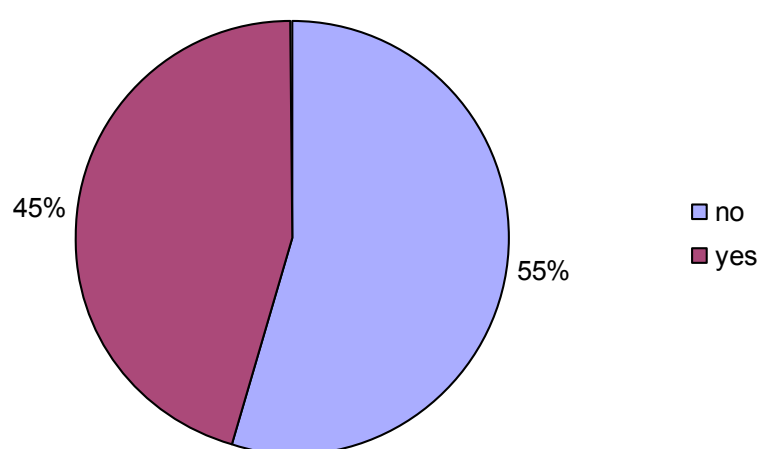


Figure 4.2: Percent households, in the HNP, practicing food grain barter (n = 108)

Grains are bartered within the neighbouring village hamlets in exchange of favors e.g. tending livestock, or exchange of other type of food grain e.g. barley bartered for wheat or peas or potatoes or to get good quality seeds. This barter system allows the residents to get a variety from a limited choice of food grains that they have. Due to a good network of food grain

storage and outlets almost an equal percent of the households were not engaged in bartering (Figure 4.3), they buy the food grains directly from the food supply outlets and from market in Leh. Some households who did not have agriculture land or had a very small land holding buy food grains as they have no other option to get the food grains.

4.3.4 Livestock holding pattern

Livestock form an important part of the hill economy and this is evident from the fact that there are ≤ 34 livestock head for each household or 6 livestock head per person. Detail of the livestock type is given in the chapter 5.

4.3.5 Human resources

The population of this region belongs to Schedule Tribe and is entitled to all the benefits as are applicable to the Schedule Tribes (STs) of the state of J&K. Census data and data from village *patwari* revealed that there are 187 households present in the study area. 108 households were sampled for the present survey and thus the sample population was 626 (Table 4.2). Sex ratio was found to be 996.7 (females per thousand males). Approximately, 53% of the sample population had undergone formal education. Human density for the study area was 3.5 persons per square kilometer. About 33% of the reported population does not live in the said village, they live either in Leh or other big settlements near Leh, either due to job outside and for education.



(a) Threshing barley with the help of local cattle in Chokdo village hamlet, HNP



(b) Winnowing of wheat carried out using tractor in Shang village hamlet, HNP

PLATE 2

Mean family size for these villages together was 5.8 ± 2.6 with a standard error of 0.25. Lowest family size was noted for Shang village cluster 5 ± 2.12 , while highest was noted for Rumbak village cluster 6.5 ± 3.2 . No significant difference was observed in the mean family size among the village clusters (Figure 4.3). However, significant difference was observed for the mean of actual number of people living in the HNP, village cluster wise [$F(3,104) = 3.301, p \leq 0.05$], where it was noted lowest for Shang, followed by Markha and Chilling clusters.

Higher percentage of males were found to be literate than the females. More number of younger people had attended school than the older people, but more older people were able to read and write the traditional *bodhi* script, as compared to the younger people.

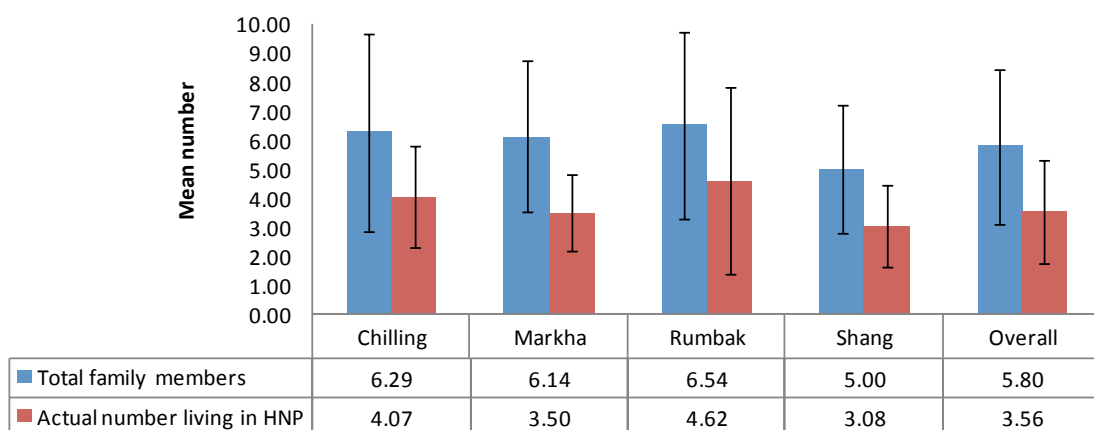


Figure 4.3: Mean family size and the mean number of persons per family residing in the village hamlets of HNP

The population of the sampled households was relatively young, where 58 percent population was below 30 years. Mean age for this population was

found to be 31.27 ± 20.55 years. 23.9% of young population lives outside the village for the purpose of attaining education and 9% live outside the HNP for service.

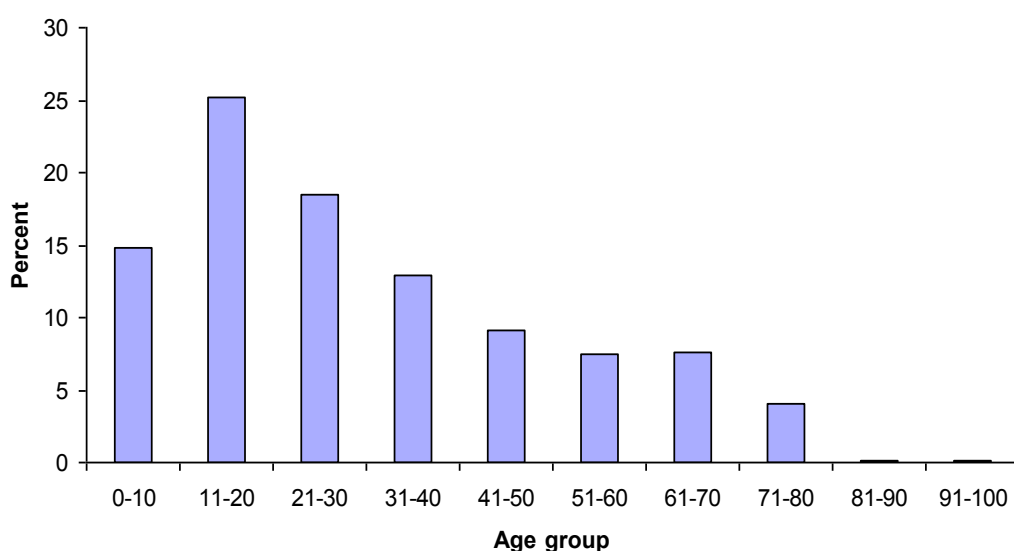


Figure 4.4: Demographic profile of the sample population of the HNP

Of the total 108 individuals interviewed representing 108 households, 61 percent were male and the rest were female. Most of the respondents (84%) were illiterate. Half of the respondent had knowledge of *bodhi* script and had learnt the language at their village from their elders. It was also noticed that the respondents who had not undergone the present system of formal education had knowledge of *bodhi* script and very few women respondent were able to read and write this script.

4.3.5.1 Migration pattern

Overall, 38.8% of the population lives outside the HNP, for job (9.4%) or for studying (29.3%) in nearby city of Leh (Figure 4.5). Significant

difference was observed in the mean number of children migrating to the Leh city for education, among the four village clusters [$F(3,104) = 2.835, p \leq 0.05$]. Highest mean was observed for the village cluster of Markha, followed by the cluster of Chilling and Shang.

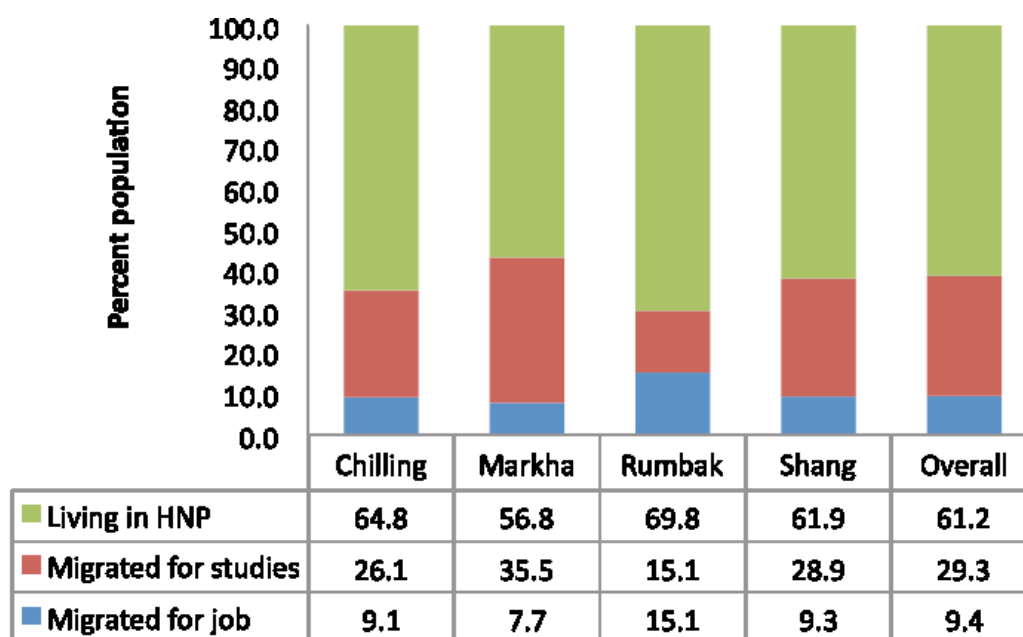


Figure 4.5: Percent population living in the HNP and migrated for job and studies (n = 108)

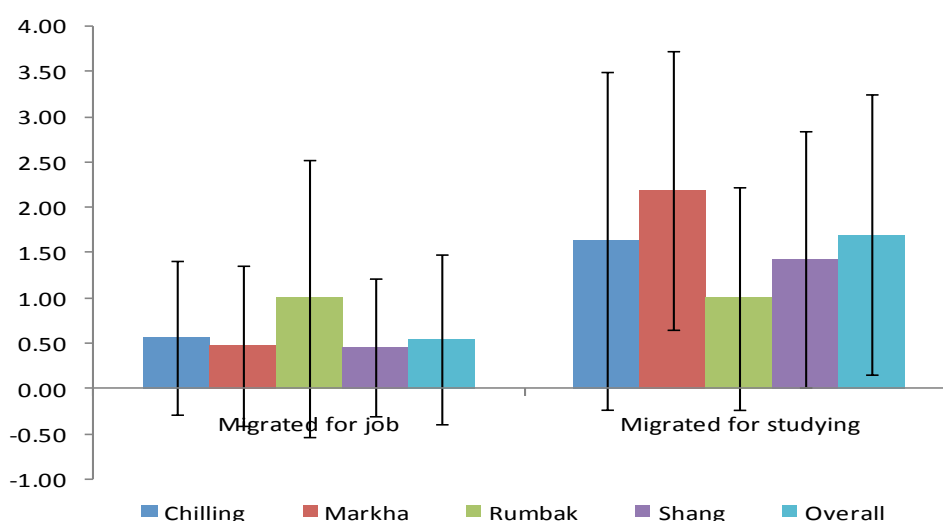


Figure 4.6: Mean number and standard deviation of the migrated population from the HNP

Out migration has been seen as one of the major trends in the study area, where young population is moving out of the villages for jobs and for education. Those people who are engaged in tourism related activities can easily afford to have another home in the city and educate their children in the bigger cities. During interviews of the local people it was revealed that people who live in Leh and other cities still are documented to be residing in these villages, by their relatives, causing discrepancy in the human population data gathered by different agencies, such as census department and the wildlife department.

4.3.5.2 Occupational pattern

Both males and females participate in fulfilling the needs of the household. Household needs are met through crops produced from agriculture, and income generated through various activities viz., tourism, jobs, small enterprises. A large number of respondents (68%) were engaged in subsistence farming activities. Trekking (12%), craft profession (5%), labor (4%), army (3%) and restaurant ownership (3%) formed the major source of occupation of the villagers (Figure 4.7). Chilling village is known for its handcrafted copper utensils, made by male members of the family. All the male respondents reporting to be engaged in traditional profession of coppersmith belonged to the Chilling village. A high percent of female respondents (90%) were engaged in farming activities, in contrast to half of the male respondents ($\chi^2 = 33.36$, $df = 17$, $p \leq 0.01$). Diversity was observed in the occupation type of the male respondents, they were occupied in trekking activities, in armed forces or had small enterprises.

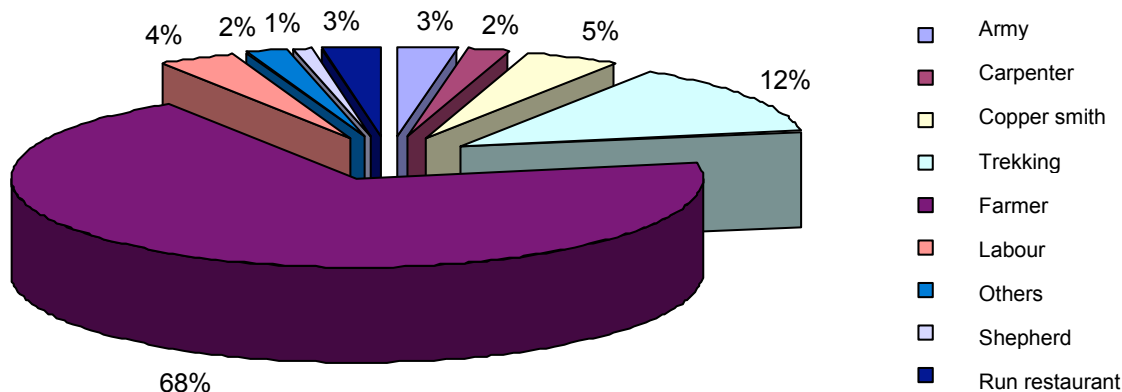


Figure 4.7: Livelihood pattern of the respondents (n = 108)

Though the economy of the study area is agro-pastoralists, yet income from agriculture is negligible as most of it is for self-sustenance. Livestock rearing provides some income along with products for self-sustenance. Livestock rearing yields milk products (dried cheese), wool, meat, skin, leather, and other services that are used for self-sustenance in the individual households. Livestock, particularly pack animals, yields income through hiring by the trek operators. Recently as a community based initiative, traditional home stays, restaurant – parachute cafe have been started as income generating activities.

Depending on the infrastructure available with each household, only 26.9% have traditional homestays, 18% had camping sites and < 8% households run parachute cafe' (Plate 5). The camping site either belongs to the entire village or to an individual household depending on the location of the camping grounds. In case of the village camping site, different norms and

regulations govern the income derived from camping fees. Camping fees was found to be similar across the study area, irrespective of the village camping ground of the individual household camping ground. Again income from these three tourism related activities varied from year to year, due to uncertainties involved with tourism influx. Heavy rains in the summers of 2006 caused damage to the camping grounds as well. Many camping grounds being located at the bank of the stream were washed away or were dumped with heavy stones, which were brought down by the heavy flow of water and the old trek routes and bridges were also washed away. About 58% persons obtained income from livestock, followed by 32% who earned income from remittances, 22% earned income thorough non-farm activities and 39% earned primary income from tourism (Table 4.4).

Table 4.4: Persons engaged in various sources of income, other than agriculture, in HNP (n = 504)

Village Cluster	Livestock	Remittances	Non-farm	Tourism
Chilling	5 (35.7)	3 (21.4)	8 (57.1)	7 (50)
Markha	37 (88)	9 (21.4)	5 (11.9)	20 (47.6)
Rumbak	11 (84.6)	7 (53.8)	2 (15.4)	10 (76.9)
Shang	10 (25.6)	16 (41)	9 (23)	5 (12.8)
Total	63 (58)	35 (32)	24 (22)	42 (39)

Figures in parentheses represent percentage

One-way ANOVA revealed significant difference in income from livestock [$F(3,104) = 14.72$, $p \leq 0.001$]; non-farm income [$F(3,104) = 2.73$, $p \leq 0.05$] and income from tourism [$F(3,104) = 4$, $p \leq 0.01$] among the four village clusters (Table 4.5).

Table 4.5: Mean annual income (INR) of the local population living inside the HNP, from various sources in the area (n = 108)

Village Cluster	Livestock*	Remittances	Non-farm*	Tourism*
Chilling	13,964 ±23,515	28,571 ±65,027	17,571 ±15,868	5,142 ±8,188
Markha	42,773 ±27,188	30,523 ±76,370	3,714 ± 10,986	5,095 ±7,706
Rumbak	31,846 ±31,196	87,384 ±1,32,018	10,000 ±33,166	10,961 ±9,826
Shang	8,551 ±18,032	55,415 ±1,05,152	6,512 ± 12,240	2,307 ±7,149
Total	25,365 ±28,621	46,103 ±94,890	7,277 ±16,534	4,800 ±8,173

**Significant difference observed at $p \leq 0.001$*

4.3.6 Resource use

Resources form an integral part of human's survival strategy. The Ladakh region belongs to the harshest climatic zone, with limited diversity of natural resources where local communities of this region have adapted through multiple uses of the limited resources. Dependency of the local communities on the resources from the national park can be classified as traditional, cultural and livelihood or it can be classified as subsistence and income dependency. The traditional and cultural dependence are usually for subsistence needs of the people and hence are subsistence in nature. Whereas the livelihood dependency usually results in income generation and hence is monetary in nature. Further, on the basis of mode of extraction of resources, dependency can be categorized into extractive and non-extractive or consumptive and non-consumptive use of resources.



(a) Uprooted *Caragana* and other plant species used as fuelwood in HNP



(b) Family carrying dry grass and fuelwood from nearby pasture in Markha valley, HNP

PLATE 3



(a) Storing the hay for winter months in Rumbak village, HNP



(a) Summer pasture at the Nimaling, Markha valley, HNP

PLATE 4



(b) Parachute-café' run by the local people along the Markha trek trail, HNP



(b) Camping site at Rumbak Village, HNP

PLATE 5

The village hamlets of Chilling and Sumda have easy access to the alternatives, as these are well connected with the city of Leh, but despite this the residents are dependent on natural resources in one way or the other. Resource extraction is often decided by the factors such as availability of a person, convenience, time taken and distance travelled to the extraction site. Economy of the residents in recent years is heavily influenced by the tourism potential of the national park. Dependence on the natural resources is extensive, not only in terms of the resources used, but also in the number of the households using them. Majority of the households use the plant species listed in Table 4.6.

Table 4.6: Plant species and their uses for the HNP

Species	Fuel	Medicine	Timber	Vegetable	Brushwood	Thatching	Crop stakes	Cultural use	Fodder
<i>Arenaria bryophylla</i>	√								
<i>Arnebia euchroma</i>								√	
<i>Artemisia</i> spp.	√					√		√	
<i>Caparis spinosa</i>				√					
<i>Caragana versicolor</i>	√								
<i>Carum curvi</i>		√							
<i>Chenopodium album</i>				√					
<i>Christolea crassifolia</i>				√					
<i>Crepis</i> spp									√
<i>Delphinium cashmerianum</i>		√							
<i>Ephedra</i> spp.	√	√							√
<i>Hippophae rhamnoides</i>	√			√			√		√
<i>Inula racemosa</i>		√							
<i>Iris lactea</i>									√
<i>Lancea tibetica</i>		√							
<i>Lindelofia stylosa</i>									√
<i>Lonicera</i> spp.					√				

Species	Fuel	Medicine	Timber	Vegetable	Brushwood	Thatching	Crop stakes	Cultural use	Fodder
<i>Medicago sativa</i>									√
<i>Mentha</i> spp.				√					
<i>Myricaria</i> spp.	√				√		√		
<i>Nepta</i> spp.									√
<i>Oxytropis chiliophylla</i>		√							
<i>Physochlaena praealta</i>		√							
<i>Podophyllum hexandrum</i>		√							
<i>Populus</i> spp.	√		√		√		√		
<i>Rheum</i> spp.		√							
<i>Rhodila</i> spp.		√							
<i>Salix</i> spp.			√		√		√		
<i>Saussurea</i> spp.		√							
<i>Stachys</i> spp.						√			
<i>Utrica hyperborea</i>				√					

All the households uses construction material (timber, thatching grass, brushwood, sand and stone), once in a lifetime, therefore, the resources needed for construction was extracted at the time of construction. While, surveying the villages no new construction was noticed, except for the village hamlet of Rumchung, where one new house was being constructed. The timber and brushwood used for construction was extracted from village woodlot and hence villagers have ownership on the timber. Thatching grass was collected from the mountains, while stones and sand were collected from the riverbed (Zanskar and Indus), which are owned by the Government of J&K.

4.3.6.1 Dependence on natural resources for income

Most of the extractive use of the natural resource from the national park's boundary is for domestic sustenance. A little part of the income is generated through harvesting of the medicinal plants, but since medicinal plant extraction needs expertise it is carried out by very few people and extraction is a time consuming activity too. Of the non-extractive use of the resources, tourism is a major income source to 39% of persons (Table 4.4).

The residents are involved in tourism related activities in many forms, such as –trekking guides, tour operators, pony and horse owners, cooks, helpers. Men are mostly involved in these activities, whereas women run restaurants and cafes – either as communal activity or as individual household activity. Traditional home-stays also earn money for 27 households of the HNP (Figure 4.8). Camping fees for the camping site also contributes to the income – community income or the household income, depending on the set-up of the camping site/ground. More than two-third of the households (69.4%) were involved in tourism related activities. Those households that were not involved in this activity were mainly from Shang village hamlet, located at the periphery of the national park and not en-route the trek trails. These villages are located on the road head and thus are well connected to the town through road and people have easy access to other sources of employment. Those households which are involved in tourism related activities earn upto INR 68,000 per annum, mainly through hiring of the horses by the trekking agencies or the independent trekkers.

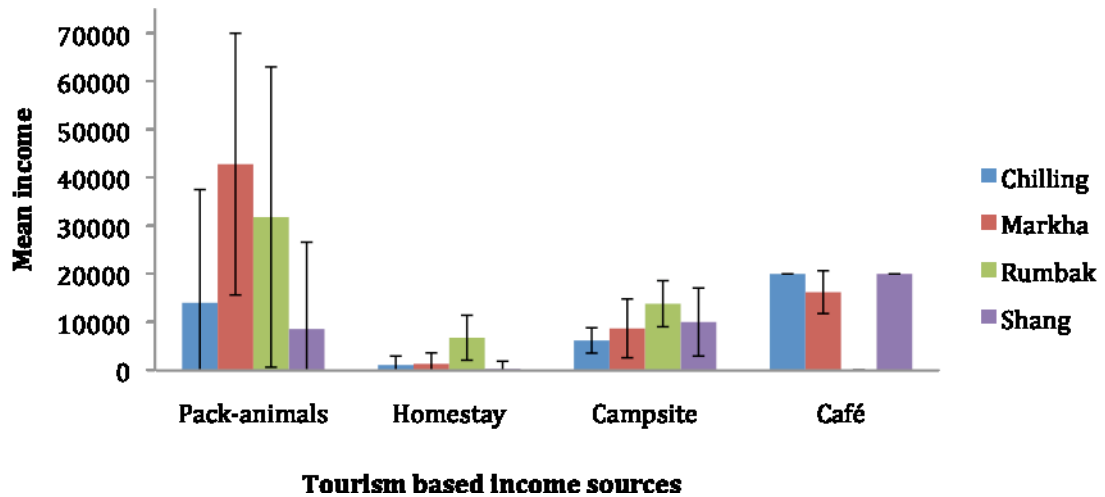


Figure 4.8: Mean annual income (INR) from various tourism related activities in the village clusters of HNP (n =108)

One-way ANOVA revealed that mean income generated through homestay was statistically different for four village clusters [$F(3,23) = 8.739$, $p \leq 0.001$] (Figure 4.8). The contribution of horse rental services to income was highest for Markha and Rumbak as a larger percent of residents from these valleys were found to be deriving income through horse rental services ($\chi^2 = 38.59$, $df = 3$, $p \leq 0.001$). Despite more number of households in the Markha valley deriving income from campsites, the highest percent of households deriving income from campsites was observed in Chilling followed by Rumbak ($\chi^2 = 11.23$, $df = 3$, $p \leq 0.001$). More than two-thirds of the households from the Rumbak valley were observed to be deriving income from homestay, followed by households of Markha and Chilling valley ($\chi^2 = 35.14$, $df = 3$, $p \leq 0.001$) (Table 4.7).

Table 4.7: Percent households from the HNP, engaged in tourism based income generating activities (n = 108)

Village Cluster	Horses*	Campsite*	Parachute cafe	Homestay*
Chilling	5 (35.7)	6 (35.7)	1 (7.1)	4 (28.6)
Markha	37 (88.1)	9 (21.4)	5 (11.9)	12 (31)
Rumbak	11 (84.6)	4 (30.8)	0	10 (76.9)
Shang	10 (25.6)	1 (2.6)	3 (7.7)	1 (5.1)
Total	63 (58.3)	20 (17.6)	9 (8.3)	27 (26.9)

** Significant difference observed at $p \leq 0.001$; figures in parentheses represent percentage*

The households derived their income from tourism either from just one option or from combination of options, depending on the alternatives and resources available to them. Analysis revealed that the tourism based income source of residents of Rumbak was the most diverse, followed by residents of Markha, Chilling and then Shang valleys ($\chi^2 = 46.9$, $df = 9$, $p \leq 0.000$) (Table 4.8).

Table 4.8: Tourism based source of income for the residents of the HNP, Ladakh

Village cluster	None	Any one	Any two	All three
Chilling	5 (35.7)	4 (28.6)	4 (28.6)	1 (7.1)
Markha	4 (9.8)	21 (51.2)	8 (19.5)	8 (19.5)
Rumbak	2 (15.4)	1 (7.7)	6 (46.2)	4 (30.8)
Shang	26 (66.7)	11 (28.2)	1 (2.6)	1 (2.6)
Total	37 (34.6)	37 (34.6)	19 (17.8)	14 (13.1)

Figures in parentheses represent percentage of households

Table 4.9: Contribution of tourism to family income for percentage households in four village clusters of the HNP (n =108)

Village clusters	None	< 25%	25-50%	51-75%	> 75%
Chilling	36	14	14	7	29
Markha	10	9	7	7	67
Rumbak	15	23	23	0	39
Shang	67	10	3	3	17
Total	34	12	8	5	41

Significant difference was observed in the contribution of tourism to the total income along the village clusters of HNP ($\chi^2 = 28.33$, $df = 3$, $p \leq 0.001$). For 45 households (41%) tourism contributed more than 75% to the family income. Highest percentages of households having more than 75% contribution of tourism in family income were from Markha and Rumbak village clusters. Higher percentage of households from Chilling and Shang were not obtaining income from tourism.

4.3.6.2 Subsistence dependence on resources

Four main resource uses were observed in the HNP, viz., vegetable collection, dung collection, firewood collection and grazing in the pastures (Plate 3 & 4). These four resources were used for self consumption only. More than half of the residents (68.5%) were reported to be extracting wild vegetables from the pastures. No significant difference was observed in the percent of households using wild vegetables. Significant difference was observed in dung collection ($\chi^2 = 30.17$, $df = 3$, $p \leq 0.001$), firewood collection ($\chi^2 = 40.52$, $df = 3$, $p \leq 0.001$) and grazing in pastures ($\chi^2 = 26.2$, $df = 3$, $p \leq 0.001$), among the four valleys (Table 4.10).

Table 4.10: Percent households living in the HNP, engaged in resource extraction (n =108)

Village Cluster	Vegetable	Dung	Firewood	Grazing*
Chilling	9 (64.3)	1 (7.1)	7 (50)	8 (57.1)
Markha	31 (73.8)	24 (57.1)	32 (76.2)	32 (76.2)
Rumbak	12 (92.3)	11 (84.6)	1 (7.7)	12 (92.3)
Shang	22 (56.4)	7 (17.9)	5 (12.8)	11 (28.2)
Total	74 (68.5)	43 (39.8)	45 (41.7)	63 (58.3)

** Significant difference observed at $p \leq 0.001$; figures in parentheses represent percentage of households*

Though small bovines are sent to summer pastures for grazing, the larger milch cattle are kept at home and stall fed all year around. The horses and donkeys used for trekking graze in pastures and are also fed on the market bought fodder. Thus, source of fodder varies with season and type of livestock. Besides easy accessibility to the market and large farms decide the source of fodder. Farm formed the source of fodder for about 90 percent of the households, with no significant difference among the households of the village clusters. Since, Markha (51 ± 44) and Rumbak (33.62 ± 20.22) villages have more livestock per household [$F(3,104) = 4.39, p \leq 0.001$] (Table 4.11).

Table 4.11: Source of fodder for households living in the HNP (n =108)

Village Cluster	Farm	Pasture*	Market*
Chilling	13 (92.9)	8 (57.1)	5 (35.7)
Markha	41 (97.6)	32 (76.2)	27 (64.3)
Rumbak	10 (76.9)	12 (92.3)	10 (76.9)
Shang	34 (87.2)	11 (28.2)	6 (15.4)
Total	98 (90.7)	63 (58.3)	48 (44.4)

** Significant difference observed at $p \leq 0.001$; figures in parentheses represent percentage*

To obtain an overall dependency score, each resource use was assigned a value of 1 and then all resource uses per household were added up. Thus the family using only any one type of resource had a dependency score of 1 and the household using all four types of resource had a dependency score of 4. Cronbach's alpha for the dependency score was found to be 0.755, signifying a high reliability of the score and the parameters taken for the score. Significant difference was observed in the dependency score among the four valleys (Table 4.12). More than half of the Markha valley households got a score of 4. Dependency score of 3 was attributed to maximum percent of Rumbak valley's residents. For residents of Shang valley major form of resource use was wild vegetables (33.3%).

Table 4.12: Natural resource dependency score for the villagers from four village clusters of HNP

Village Cluster	Score 0	Score I	Score II	Score III	Score IV
Chilling	3 (21.4)	3 (21.4)	2 (14.3)	6 (42.9)	0
Markha	4 (9.5)	4 (9.5)	8 (19)	4 (9.5)	22 (52.4)
Rumbak	1 (7.7)	0	1 (7.7)	10 (76.9)	1 (7.7)
Shang	15 (38.5)	13 (33.3)	0	11 (28.2)	0
Total	23 (21.3)	20 (18.5)	11 (10.2)	31 (28.7)	23 (21.3)

A score of 0 represents no dependency, while 4 represents dependency on all four resources. The scores do not specify the quantity of dependency;

** Significant difference observed at $p \leq 0.001$;*

Figures in parentheses represent percentage of household

In all, 23 households were not using any form of resource from HNP, as these households comprised either of old and lonely people, or less number of people in the households or the households were occupied most of the times in agriculture activities (as in Shang valley) and hence did not have

time to go for resource collection. Since, collection was done for self most of the households in the park's boundary are the users. Highest percent of non-users were noted for the village cluster of Shang (38.5%) and Chilling (21.4%). Villagers of the Rumchung and Zingchen sell the timber grown on the village woodlots and the private orchard. Some prefer to bring firewood from mountains rather than the village woodlot, as mountains is near by than the village woodlot.

Regression analysis was carried out to find if the dependency score had a relation with the independent variables revealed that dependency increased with increase in the distance of the village hamlet from road, livestock holding and agriculture holding. The model described 36.8% of the variance in dependency score (Table 4.13), and significantly explained the relationship [$F(6,101) = 9.81, p \leq 0.001$] (Table 4.14).

Table 4.13: Model Summary for dependency score

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.607 ^a	0.368	0.361	1.182

Table 4.14: ANOVA for regression model

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	86.112	6	14.352	9.81	≤ 0.001
	Residual	147.768	101	1.463		
	Total	233.88	107			

Table 4.15: Regression model statistics

Model		Coefficients		t-value	p-value
		B	Std. Error		
Variables	(Constant)	0.638	0.415	1.538	0.127
	Distance score	0.348	0.120	2.991	0.004
	Livestock holding	0.010	0.003	3.228	0.002
	Family members	0.029	0.071	0.416	0.678
	Agriculture land (acres)	0.176	0.072	2.451	0.016

- a. **Predictors:** (Constant), Distance score, Agriculture land in acres, Total livestock, Number of family members
- b. **Dependent Variable:** Dependency score

With other variables held constant, dependency score was positively related to distance, where dependency score increased by 34% for increase in a unit of distance. Similarly, dependency score increased by 1%, 2.9%, and 17.6% for increase in a unit of livestock holding, family members, and increase in agriculture land, respectively. However, except for the family members, the other three variables explained the dependency score significantly (Table 4.15).

Collection of the natural resources is a seasonal activity and usually takes place during and after harvesting period, *i.e.*, between August till early November. All major labour-intensive work is carried out during this period. Though fuel wood is collected during the early part of the year as well, but intensity of fuelwood collection increases in the autumn. Cow dung is also collected intensely during this period. A decision to spend a lot of time on low-return in-forest activities indicates that there is limited access to alternative sources of income and a correspondingly high dependence on the natural

resources. The villagers of Shang, who did not go to collect resources, supplemented their income from the agriculture produce. Of all the in-park activities, most of the time was spent for grazing activity, followed by time spent on collection of fuel resources and fodder. In many cases the old people who otherwise were not able to do difficult tasks were engaged in collecting the dry shrubs and the cow dung, for fuel.

Time spent on collection of the natural resources depends on season and availability of human labor at home. Construction of house is usually done once in a lifetime and hence the stones and sand gathered for construction of house is done as per need. Sand is needed once in two year for repairing work. The timber and brushwood used for construction of the house is collected as per need, collection of timber is done once in 30-40 yrs for a house whereas brushwood is collected once in every five years.

Fodder need of the stall fed animals is usually met by farm produce. But percent of stall fed livestock is low, and the large bodied animals are usually stall fed in winters. Most of the time, the large bodied animals graze openly, in the pastures nearby or at a distance. Small livestock are sent to far off pastures, accompanied with a shepherd. While the large bodied livestock, are usually left at a pasture which can be easily watched from the house, fields and camping sites.

4.3.6.3 Cultural connection to the natural resources

Buddhist community living all over the Ladakh region have strong and long-standing cultural connections with the natural resources, and this connection dates back to the time when Buddhism was not spread in Ladakh, when the pagan system was practiced in Ladakh and the animal parts were used as totems (*pers comm. with Dr. Jina*). Keeping the horns of the dead animals at village entrance and at the entrance of the house is one of the most common cultural behaviour observed (Plate 8). The Buddhist population use dried leaves of Junipers and *Artemisia* spp. daily as incense and also during special ceremonies, like birth, marriage, festivals, death etc. The juniper and *Artemisia* spp. are collected and sold in market of Leh and nearby villages.

4.3.7 Wildlife values in HNP

4.3.7.1 Status and distribution of wild mammals

Wildlife of the HNP includes sixteen mammal species, as has been reported from time to time, through occasional sightings starting from Mallon (1984) and Fox et al. (1991) (Table 4.16). The distributional range of these mammals has been mapped at the Wildlife Institute of India (WII), for entire Ladakh region (Chundawat & Qureshi 1999).

Table 4.16: Status and distribution of the wild mammals in the HNP

Species	Distribution	Area	Population Estimates (Individuals)	Reference
<i>Pseudois nayaur</i>	Wide	Throughout HNP	1000	Mallon (1984)
<i>Ovis ammon hodgsoni</i>	Restricted	Rumbak Valley	20	Namgail (2001)
<i>Capra ibex siberica</i>	Restricted	West of Zaskar river	20	Anon (1986) in Fox & Nurbu, (1990)
<i>Ovis vignei vignei</i>	Restricted	Confluence of Zaskar and Indus; Sumdah and Shang valley	300	Mallon (1991)
<i>Equus kiang</i>	Restricted	Eastern Chang chu valley, Rubrang nullah	< 50	Osborne et al. (1983), Mallon & Bacha (1989)
<i>Canis lupus chanco</i>	Wide	Throughout HNP	Not estimated	Fox & Nurbu (1990)
<i>Vulpes vulpes Montana</i>	Wide	Throughout HNP	Not estimated	Anon. (2007)
<i>Panthera uncia</i>	Wide	Throughout HNP	Not estimated	Anon. (2007)
<i>Mustela altaica</i>	Restricted	Sighted in Markha valley	Not estimated	Shawl et al. (2008)
<i>Martes foina</i>	Restricted	Lower region of HNP	Not estimated	Shawl et al. (2008)
<i>Felix lynx</i>	Restricted	Sighted in Chang chu, Markha and Rumbak valleys	Not estimated	Fox et al. (1986) Sharma & Dutta (2005)
<i>Cuon alpinus</i>	Wide	Throughout HNP	Not estimated	Shawl et al. (2008)
<i>Lepus oiostolus</i>	Restricted	Rumbak, Chang-chu, Markha, west of Zaskar river	Not estimated	Anon. (2007)
<i>Ochotona marotis</i>	Wide	Throughout HNP	Not estimated	Anon. (2007)
<i>Marmota bobak/ M. himalayana</i>	Restricted	Restricted to upper Markha valley	Not estimated	Shawl et al. (2008)
<i>Alticola argentatus</i>	Restricted	Restricted to Changchemno valley	Not estimated	Shwal et al. (2008)

Pseudois nayaur (Blue sheep) is the most widely distributed wild ungulate of the region, having representative populations in all the valleys of the HNP. In contrast, the population of other wild ungulates is restricted to small patches, as has been reported for the Ladakh urial and Tibetan argali from Rumbak valley. Namgail et al. (2004) reported a population of 20 individuals *Ovis vignei vignei* from the upper Rumbak valley in the catchment of Yurutse in an area of 10 sq km. Owing to its uniform distribution in the HNP, Blue sheep was the most commonly and easily sighted ungulate. During

the study period, a total of 24 observations, covering 80 km trails, were made. Sightings were made between 6000 hrs to 1800 hrs. Significant difference was observed in the activity pattern of sighted groups, with respect to the time of observation. Most of the sightings (75%) made during early hours were of movement, whereas all the resting observations were recorded during evenings, 60% of the feeding observations were made during evenings. Ungulates were sighted as close as 0 km from the village to as far as 8 km from the villages. Lowest elevation at which Blue sheep were sighted was around 3200 m asl, while the highest elevation was about 4800 m asl. Overall mean group size of 16.2 (± 2.46) and an encounter rate of 5 (± 1.32) individuals per sq km was observed for Blue sheep in the study area. Highest mean group size and encounter rate was observed in Rumbak valley (Table 4.17). Highest mean group size and encounter rate was noted for sites near the water sources, agriculture fields and mid-distance from habitations (Table 4.18).

Table 4.17: Mean group size and encounter rate for Blue sheep in the HNP

	Rumbak	Markha	Shang	Overall
Mean group size	23.5 (± 8.5)	15 (± 1.11)	12.3 (± 2.75)	16.2 (± 2.46)
Encounter rate (individuals/km)	10.5 (± 4.8)	4.8 (± 0.55)	4 (± 0.76)	5 (± 1.32)

Table 4.18: Mean group size and encounter rate, according to distance from human settlement for Blue sheep in the HNP

	< 2 km	2 – 5 km	> 5 km
Mean group size	16.8 (± 2.8)	21.5 (± 5.3)	9.4 (± 1.46)
Encounter rate (individuals/km)	5.4 (± 0.63)	8.5 (± 3.3)	3.4 (± 0.91)

4.3.7.2 Vegetation composition and structure

A total of 57 species were encountered in 100 plots across the trails in Rumbak and Markha valleys of the HNP. Higher number of plant species were recorded from 2-5 km distance from human habitations compared to < 2 km and > 5 km; higher number of plant species were found in lower elevation zone as compared to the higher elevation zone (Table 4.19).

Xerophytic species viz. *Tanacetum* spp., *Stachys tibetica* and *Artemisia* spp. (*brevifolia*, *gmelinii* and *macrocephala*) were the most widely spread shrub species across the study area, with 736, 580 and 516 plants per ha respectively. Among the herbaceous vegetation, *Potentilla* spp., was most common with 354 plants per ha. Density of sedges such as *Kobresia schoenoides* and *Poa attenuata* was recorded to be 1.82 and 1.55 tufts per meter square.

Near human habitations, *Stachys tibetica* was most common (810 plants per ha), followed by *Tanacetum fruticosum* (740 plants per ha). At 2-5 km range, *Tanacetum fruticosum* was most common (733 plants per ha) and at > 5 km from habitations, *Artemisia gmelinii* was the most abundant shrub (1290 plants per ha). At this distance, *Tanacetum fruticosum* was replaced by *Tanacetum tibeticum*, *Carex*, *Kobresia schoenoides*, *Waldhemia tomentosa*, *Youngia tenuifolia*, with *Allium oreoprasum*, *Erigeron bellidioides*, *Lactuca tatarica*, *Urtica hyperborea*, *Taraxacum officinale* were found to be absent from < 2 km range from permanent human habitations.

Rosa spp., *Salix* spp., *Populus* spp., *Nepeta leucolaena*, *Echinops cornigerus*, *Berberis ulcina*, *Capparis spinosa*, *Chenopodium* spp., *Cousinia thomsonii*, *Myricaria germanica*, *Physochlaina praealta*, *Rumex patientia* were found to be absent at distance more than 5 km from habitations.

Potentilla bifurcata and *Potentilla* spp. were observed to be common along all the sites, *Echinops cornigerus* and *Physochlaina praealta* were the most common near the habitations, *Kobresia schoenoides*, *Poa attenuata*, *Dracocephalum*, *Nepeta leucolaena* were common at a distance of 2-5 km from habitations, while *Poa attenuata*, *Carex* spp. and *Aconogonum tortuosum* were most common at more than 5 km from habitations.

Attitudinally, shrub density was found to increase with increasing elevation. *Tanacetum fruticosum* was found to be most dense in low elevation zone and *Artemisia* most dense at > 3970 m. Highest herb density of 60.3 plants per meter square was recorded for *Potentilla* at higher elevation zone, which was followed by the density for *Kobresia schoenoides* and *Poa attenuata*. At lower elevation zone, *Nepeta leucolaena*, *Physochlaina praealta* and *Dracocephalum* spp. were most dense. At lower elevation zones, *Urtica hyperborea*, *Taraxacum officinale*, *Thylospermum*, *Rumex* spp., *Rhodila*, *Halerpastis*, *Allium oreoprasum*, *Chrysanthemum* and *Lonicera* spp. were not recorded. While *Capparis spinosa*, *Perovskia abrotanoides*, *Lancea tibetica*, *Erigeron* spp., *Crepis flexuosa*, *Myricaria germanica* were not recorded at higher elevations.

The valley bottoms, along the streams had the most dense vegetation cover, as the river valleys have both natural and planted vegetation. The vegetation cover was found to be 24.8%, minimum cover of 1% was noted for *Capparis spinosa*, *Crepis flexuosa*, *Nepeta leucolaena* while 80 to 85% was noted for the *Caragana* association and the highest ground cover > 90% was noted in the marshy grasslands and alpine grasslands with *Poa attenuata* and *Kobresia schoenoides* associations. Vegetation cover was found to increase with increasing altitude (15.54% for up to 3970 m; and 26.49% for 3970 m and above), while decreased with distance from water or valley bottom. The vegetation cover was observed to decrease as the distance from human settlements increased, but then the cover was found to increase at a distance of more than 5 km from village settlements.

Table 4.19: Comparison of vegetation characteristics according to distance from human habitations and elevation, in the HNP

Vegetation parameters	Distance from habitations			Elevation categories		Overall
	<2 km	2-5 km	> 5 km	< 3970 m	> 3970 m	
Species richness (R)	31	36	25	45	34	57
Shannon Diversity Index (H')	2.9	2.6	2.5	1.42	2.76	3.2
Simpson's Evenness Index (D)	0.07	0.14	0.12	0.06	0.09	0.06
Herb density m ⁻²	14.98	14.03	17.06	15.32	26.49	15.57
Shrub density ha ⁻¹	2220	1293	3200	1948	2535	2268
Vegetation cover (%)	21.16	18.59	22.33	15.54	26.49	21.04

4.4 DISCUSSION

The human landscape in the HNP was found to be similar as noted by Dame & Nüsser (2011) for Ladakh, where typical land use pattern consist of small houses with agricultural fields, pastures, village woodlot, intertwined with the nearby natural water sources. The social and economical setup of the study villages reveals a larger family size (5.8), with a range of 4 to 7 family members. But in most of the cases only 2 or 3 persons were found living in the households, on a regular basis. This was due to several reasons, that the younger members of the household were either studying in the Leh or were employed in the places outside the village, in some cases members of the households were engaged in tourism activities and thirdly that those family members who had shifted to the city nearby were also reported to be living with the original family. The family size is lower than that found by Bhatnagar et al. (1999) for the same region, implying that family size has reduced as most of the residents have started living in the city of Leh, for education and a paid job and the emergence of nuclear families (Goodall 2004).

Higher sex ratio (993/1000) was observed for HNP compared to the rest of India (933/1000) as per 2001 census, and was also higher than that for the rural Leh district *i.e.*, 904/100. Female infanticide is zilch in the Himalayan region and traditionally women have been accorded greater freedom compared to the women from other parts of the country.

The population of the region is young, where most of the residents (55%) are below 30 years, about 40% of the population is below 20 years, suggesting a higher birth rate. Literacy rate was found to be 53%, which is

lower than that for the whole of India (65.4%) and that for the Leh district (65.3%) but was higher than that for the state of J&K (47.4%). The male and female literacy rate was also higher compared to the rural J&K, 52% and 30.1%, respectively. When compared to the literacy rate for the rural Leh district (60%), the literacy rate for study area was found to be lower, and similarly male literacy level for rural Leh (71%) was greater than that for male from the study villages, female literacy level was same for the rural Leh and the study villages (48%). Literacy rate seems to have increased since 1999, which was 37% and 18% for male and female respectively (Bhatnagar et al. 1999). Most of the villages had primary school earlier, but now since more and more families are able to afford better education in the towns and cities, they prefer sending their wards to the school in city and town and as a result due to lack of students in the villages the primary schools are closing down, Rumbak village is a classical example of such a shift. Middle school is present in Markha village, which caters to the education need of almost entire Markha valley and for obtaining education beyond 8th grade students usually go to Leh.

Ladakh is one of the most sparsely populated regions of India. Population density for the Leh (Ladakh) is 3 persons per square kilometre and that of the study area was found to be 3.5 persons per square kilometre. Population density for the state of J&K is 99.7 persons per square kilometre, and that for the whole of India is 382 persons per square kilometre (Source: 2001 Census – www.censusindiamaps.net).

Ladakh is primarily inhabited by the agro-pastoral communities and hence most of the people from the study area are engaged in subsistence agriculture activities, but these are also the people who are left in villages, especially women and old people. Except, permanent jobs in government and private sectors, all other livelihood activities recorded from the region are seasonal in nature. Farming activity is also taken up as part- time activity by those who are engaged in seasonal income generating activities, such as tourism. Permanent jobs in government and private sectors, together provides employment to only 4% of the residents. Those who are not directly involved in trekking activities, still earn through the tourism activities as they provide their horses and donkeys to the tour operators directly or through mediators. Traditional homestays, camping sites and restaurants were also the seasonal income generation and it did not require much effort on the part of the worker, except for running restaurant. Leh district has about 38% people as cultivators, which is lower than that of the study villages. Percent worker in agriculture sector from the study area was higher than that for the Leh district, total (42.2%) and rural (54.6%), suggesting focus of income generation on other activities as well, viz., tourism, livestock.

Average livestock holding per household was high, though smaller livestock forms the bulk of the livestock holding in the region, and similar trend is observed across the Ladakh region, where population is mainly agro-pastoralist. Livestock holding was lower than that reported by Bhatnagar et al. (1999) (50 animals per household) and was higher than that found in Kibber wildlife sanctuary, Spiti, Himachal Pradesh (13 livestock per household) (Mishra 1997a).

Almost half of the resident houses were engaged in barter system, making it possible for them to have a diversity of the food grains and it suited the local dietary habits as well. Solar electricity has been a major source of power in the Ladakh region, the high intensity solar radiation fulfils power need for the most of the rural Ladakh, where water is scarce and freezes in winter, thus making hydro-power projects a challenge. Small solar panels accompanied with the solar bulbs and tube lights are distributed to the villagers at subsidized cost by the LAHDC. With increase in purchasing power of the residents, more and more houses are obtaining various amenities for use and luxury. As 83% households from the study area had a radio or a transistor, compared to 65% and 61% of the households of Jammu & Kashmir total and rural respectively. The number of households having a television set is lower than that for the total and rural Jammu and Kashmir 40% and 29% respectively. The residents do have a motor run vehicle, but in most of the cases it is stationed at Leh city or the nearby village and usually the younger ones own them and are used for tourism activities.

Vegetable collection is usually done in spare time between the end of the tourism season and start of winters. Only one particular vegetable (Nettle) is extracted to be eaten during winter months, as the vegetable is supposed to be medicinal in nature. Most of the respondents collected vegetable as part of cultural and habitual connection. Hence, no significant difference was observed for the percent of villagers from each clusters extracting vegetable. Dung collection among four village clusters was found to be significantly different. Most of the inhabitants of the Rumbak (84.6%), more than half of the

households of Markha (57.1%) were observed to be involved in dung collection, in contrast to 17.9% households of Shang and 7.1% of households of Chilling village cluster. The village clusters of Chilling and Shang are located near road head, with easy access to other fuel as source of energy, hence less percent of respondents from these clusters were observed collecting dung. More percent of the inhabitants of these village clusters were found to be engaged in other income related activities suggesting that they spend more time on income activities, rather than subsistence activities (dung collection). Percent of households dependent on firewood collection was found to be significantly different among four village clusters. Firewood collection was reported by more than one-third (76%) inhabitants of Markha village cluster, and by half of the respondents (50%) of villagers from Chilling and just one family from Rumbak village cluster. Easy access to alternate fuel source for villagers of Shang and Chilling valley explains this, as has been reported by many studies (Ashley & LaFranchi 1997, Badola 2000, Mamo et al. 2007, Babulo et al. 2009, Coulibaly-lingani et al. 2009, de Medeiros et al. 2012).

Percent of households involved in livestock grazing on the pasturelands was found to be significantly different among the village clusters. High percent (92.3%) of inhabitants from Rumbak cluster sent their livestock for grazing, followed by 76.2% from Markha and 57.1% from Chilling clusters. Only 28.2% inhabitants of Shang cluster used the pastureland for grazing livestock. Large agriculture fields, multiple crops and crop residue, permanent source of income, nearness to market, observed for households of the Shang cluster, makes it possible to stall feed the cattle and other livestock.

The residents of HNP have traditionally been using the resources from within the park's boundary. With notification of the area as National Park, the rights of local communities were neither noted and settled down nor were curtailed (Anon. 2007), unlike the use rights of residents of other National Parks of India. Hence, the local community living with the HNP uses resources for self-sustenance and income generation. Use of natural resources has been a function of the local or regional socio-economic activity (Moench 1991). The number of livestock in a village determines the fodder need. This fodder can be from the agriculture farms and the pastures, the village agriculture production system and amount of fodder produced from agriculture land determines the non-forest component of fodder supply. Results of the study are in coherence with the study by Moench (1991). The livestock are grazed on communal lands/pasture within the boundaries of HNP, in the summer months. The smaller livestock, sheep and goats are usually sent to the high altitude pastures for grazing during summers with two to three people from the village, while the other large livestock are either stall fed, or sent to nearby grasslands on daily basis. The demand of fodder, in winter months is fulfilled either from the farm residue or fodder from market. For the residents of villages, farm, pasture grazing and market all are sources of fodder. About 91% residents used farm residue and 44.4% bought fodder from market, whereas 58% sent their livestock for grazing on pasturelands. No significant difference was observed in use of crop residue, as fodder by the residents of these village clusters. Significant difference among village clusters was observed in fodder being bought from market. More percent of Rumbak (76.9%) and Markha (64.3%) residents bought fodder from market

compared to others. Small landholding size and high livestock owned per family for these clusters explains the need to buy fodder from market. Significant difference was also observed in the percent of households sending their livestock to the pasturelands. High percent of Rumbak's residents (92.3%) sent their livestock to the pastures, compared to 76.2% residents of Markha and 57.1% residents of Chilling village cluster.

Overall, 34.6% families did not derive income from tourism activities, of these 66.7% belonged to the Shang village cluster and 35.7% to the Chilling village cluster. Of activities such as hiring of horses, running cafes and camping sites, 34.6% families were noted to be deriving income from either of these activities, with highest percent recorded for Markha residents, followed by residents of Shang and Chilling. Highest percent of residents from Rumbak village clusters were found to be deriving income from any two or any three tourism based income activities. Hence, more percent of Rumbak's residents had tourism based income generation options, followed by residents of Markha village cluster. Most of the residents of Chilling were involved in any two, income generation activities.

General income activities diversification was noted to be maximum for the residents of Chilling and Shang village clusters, whereas the residents of Markha and Rumbak derive income from tourism options only. This dependence on seasonal tourism makes them susceptible to changes in tourism and PA policy. With limited options, the present situation of deriving maximum income from tourism in the Markha and Rumbak clusters is the best option to meet the sustainability model, where non-consumptive resource use

contributes significantly to the livelihoods. Location of the villages plays an important role in determining access and dependence on resources, livelihood strategies, diversification of livelihoods and coping with the changes. Findings of the present study are in consonance with findings by Badola (1997), de Sherbinin et al. (2008), Quang & Anh (2006) where dependency increased with increase in distance from market (fair-weather road), access to alternates in terms of purchasing power and nearness to markets.

The mean group size of Blue sheep was found to be 16.2 (range = 4-42), similar range and group size has been recorded for blue sheep by Namgail et al. (2010b) for Gaya-Miru Wildlife Sanctuary and Namgail et al. (2009) for HNP in Ladakh. It has been established that lower density of ungulate is due to competition from the livestock for food and space (Prins 1992, Mishra et al. 2004). Low density of Blue sheep was ascertained to intensively grazed rangelands compared to the moderately grazed rangelands (Mishra et al. 2004) in Spiti, Indian Trans-Himalaya. In the present study, low density of Blue sheep (0.34 km^{-2}) for the entire area of Rumbak, Sku-Markha and Shang catchments, higher encounter rate near the human habitations and reports of crop damage by the ungulates, suggests high level of competition between *Pseudois nayaur* and livestock in the study area. At the time of Blue sheep sightings, most of the livestock from village hamlets were in the summer pastures, located at more than 5 km from the village, low encounter rate at summer pastures than near the human settlements suggests blue sheep presence to be inversely related to livestock presence as has been found by Bhattacharya et al. (2011).

Studies have established a positive relation between increase in number of plant species and anthropogenic influence, resulting in more artificial vegetation (Paillet et al. 2010, Kiss et al. 2011, Yang et al. 2012). Higher number of species near the village settlement could be due to the agriculturally induced diversity and also due to presence of weed species, such as *Artemisia macrocephala*, *Rumex patientia*, *Physochlaina praealta* (Klimes & Dickore 2005). Whereas lower number of species at larger distance from human settlements and also at higher elevations could be due to naturalness of the sample sites due to less anthropogenic interference, accompanied with reduction in temperature (Rahbek 1995, Vetaas & Grytnes 2002). Abundance of natural herbaceous vegetation such as *Aconogoum tortuosum*, *Artemisia* spp., *Caragana*, *Carex*, *Dracocephalum*, *Kobresia*, *Potentilla*, *Rheum*, was found to increase with increase in elevation in the study area. Similarly, abundance of weed species such as *Echniops*, *Nepeta leucolaena*, *Physochlaina praealta* was found to decrease with increasing distance from human habitations and increasing elevation. Decrease in abundance of xeric elements such as *Tanacetum* spp., *Stachys tibetica*, *Berberis ulicina* with increase in elevation has been observed in the study area similar to observation made by Singh (2009).

Despite less number of plant species recorded for the higher elevation, high diversity index was calculated for the same in the study area. Hump shaped curve has been observed for species richness along altitudinal gradient, where species richness increases with altitude and then stabilizes, followed by decline in species with increase in altitude. Klimes (2003) observed similar pattern for floral diversity of Ladakh region. The hump and

decline is ascribed to water limitation at lower elevations and temperature limitation at higher elevations, respectively.

High abundance and density of *Kobresia* in the mid distance zone suggests higher grazing pressure and results are similar to the findings of Bock et al. (1995) and Klimes (2003), where dominance of clonal species of graminoids is in accord with the grazing history of the region. Low density of the ungulate species, along with presence of more weed and introduced species at mid distance from permanent human habitations, suggests higher anthropogenic interference near villages, which decreases with increase in distance from human habitations in the study area.

4.5 SUMMARY

Subsistence agriculture is the main livelihood of the people. Livestock, tourism, remittances, and traditional craftsmanship were other sources of income. Income from tourism varied significantly along the village clusters of HNP ($\chi^2 = 28.33$, $df = 3$, $p \leq 0.001$). For Markha and Rumbak tourism contributed the most towards total income. For Chilling and Shang village clusters remittances formed the major contributor to family income.. Tourism based income source of residents of Rumbak were the most diverse, followed by residents of Markha, Chilling and Shang valleys ($\chi^2 = 46.9$, $df = 9$, $p \leq 0.001$).

Firewood, dung, vegetable collection and grazing within the Park's boundary are the major form of resource use by the local people for self use

(Plate 3). Dependency score generated by adding the number of resources (either firewood, dung, vegetable or grazing or in combination) used by the households was highest for Markha and Rumbak village clusters ($\chi^2 = 74.36$, $df = 12$, $p \leq 0.01$).

Higher dependency of residents Markha and Rumbak's on resources of HNP and income from tourism makes them vulnerable to environmental change. Therefore, the management must focus on the ways to meet the need of the people to maintain the integrity of the habitat. Prescribed rotational grazing with specified number of livestock in the area could be one way to reduce the pressure on habitat. Promotion of community based tourism could be another option to reduce the dependency of local communities on natural resources. The tourism plan for the area must ensure continuous flow of tourism benefits to the local people, through proper monitoring and evaluation of the community based tourism.

In the study area the abundance of natural vegetation such as *Aconogoum tortuosum*, *Artemisia* spp., *Caragana*, *Carex*, *Dracocephalum*, *Kobresia*, *Potentilla*, *Rheum* were found to increase in proportion with increase in elevation while the abundance of weed species such as *Echniops*, *Nepeta leucolaena*, *Physochlaina praealta* were found to decrease with increasing distance from human habitations and increasing elevation. High abundance and density of *Kobresia* in the mid distance zone suggests higher grazing pressure.

In the study area the occurrence of large ungulates viz. Ladakh urial (*Ovis vignei vignei*), Tibetan argali (*Ovis ammon hodgsoni*), Siberian ibex (*Capra ibex siberica*) and Wild ass (*Equus kiang*) was restricted to a smaller areas while the population of Blue Sheep/Bharal (*Pseudois nayaur*) was found all along the trek routes and human habitations of the HNP. Eight trails of length from 2 to 4 km were monitored twice during 2006 for getting information on ungulate species found along the trek trails of the HNP. The encounter rate and mean group size of Blue sheep was found highest for the Rumbak valley and mid-distance from the village hamlets.

Higher abundance of Blue sheep and of weed species at mid distance from permanent human habitations, suggests that the Blue sheep utilize lower productive grasslands, as higher productivity grasslands were occupied by the livestock re-emphasizing the theory of competitive exclusion of wild ungulates from productive habitats. The rotational grazing as suggested and traditional migratory grazing practices could reduce the competition between wild ungulate and livestock. Zonation of critical wildlife habitats could also be considered to reduce competition for forage and space. This would mean delineating trek routes where livestock and pack animal movement should be kept minimal to avoid disturbance to wild ungulate habitat.



Chapter 5

HUMAN-WILDLIFE INTERACTION IN HEMIS NATIONAL PARK

5.1 INTRODUCTION

Under the current scenario, most PAs are facing economic and psychological loss to humans and threat of extinction of the wildlife (Inskip & Zimmerman 2009, Treves 2009, Karanth et al. 2010). It is widely known, that increasing human population, expansion of human uses of wildlife habitats, recovery of wildlife populations and climatic changes are bringing wild species into close interspersed with human population leading to increased instances of interaction between them (Breitenmoser 1998, Gompper 2002, Treves et al. 2002, Knight 2003, Naughton-Treves et al. 2003, Cope et al. 2005, Raik et al. 2005, Hunter et al. 2007, Regehr et al. 2007).

The term “interaction” implies both negative and positive association between human and wildlife. While wildlife threatens the local economy, the consumptive (e.g. sale of timber, fuel and NTFP) and non-consumptive resource use (e.g. tourism income) from the PA boundary provides the opportunity to forego the losses due to wildlife’s presence (Hamilton 2004). Tourism inside the PAs provides an opportunity to reduce poverty and secure livelihoods of the communities living in ecotourism sites across Africa, Latin America and Asia (Ashley et al. 2001, Badola et al. 2010).

Figure 5.1 represents the continuum of human-wildlife interaction, where high physical interaction represented through hunting, culling, predator control, competitive grazing has the highest negative impact on wildlife populations through killing or local extinction and on local communities through loss of livelihood and lost access to resources. Whereas, the low physical interaction between the wildlife and the local community represented through non-consumptive resource use, conservation and bequest value has the maximum potential for co-existence of human and wildlife (Duffus & Dearden 1990).

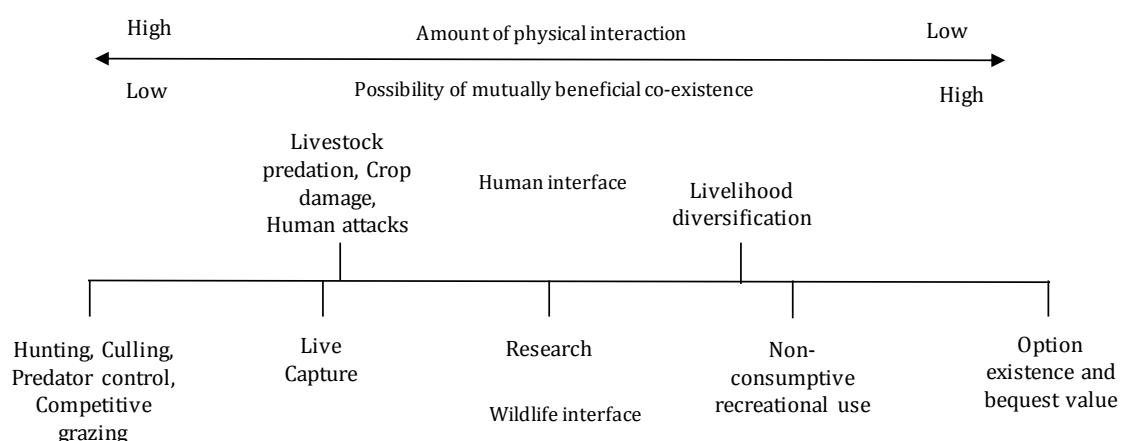


Figure 5.1: A continuum of human-wildlife interaction (adapted and modified from Duffus & Dearden 1990)

Livestock contribute significantly to the economy of the rural people and this is especially true in context of the mountain areas (Pun & Mares 2000). The rangelands of the Ladakh support both the domestic ungulate and the wild ungulate populations. Both the wild and the domestic population interact with each other in one-way or the other. This interspersion results in forage competition, and local extinction of the wild herbivores and loss of the livestock due to predation by the carnivore species (Mishra et al. 2002, 2004). Livestock predation by Snow leopards and Tibetan wolves are primary causal

elements of human-wildlife conflict in the Trans-Himalayan belt (Schaller 1977, Fox et al. 1988, Mallon 1991, Oli et al. 1994, Meriggi & Lovari 1996, Nowell & Jackson 1996, Mishra 1997a, Bhatnagar et al. 1999). This loss has financial as well as psychological implications and retaliatory killing were earlier followed by the cases of livestock loss and negative attitude of the local populace towards the wild population and conservation measures. In the case of Ladakh, the species involved in the human-animal conflict are highly imperilled and pose a serious threat to the economy of the people and thus resulting in acute conflicts. Tourism has emerged as an important livelihood source for the communities of HNP and other Trans-Himalayan region, where as many as 5000 visitors were reported visiting the HNP in 2001 (Jackson et al. 2003). Till now the studies undertaken in the Trans-Himalayan belt have considered only livestock predation associated losses and overlooked the benefits derived by the local people due to their proximity to wilderness area. This chapter provides results of the study undertaken in the HNP, to obtain the losses and benefits accruing to the local community due to their close interspersed with the wildlife.

5.2 METHODS

To evaluate the magnitude and degree of human-wildlife interaction, in the HNP, data on losses and benefits accruing to the local people was generated through questionnaire survey in four village clusters. Information was sought from 108 households of the HNP. Since, focus group discussion, semi structured interviews with the village elders, key resource persons and literature review revealed that the region primarily has a history of livestock predation by Snow leopard (*Panthera uncia*) (Schaan) and Tibetan wolf

(*Canis lupus chanco*) (*Shanghku*), the questionnaire was designed to obtain information on number of livestock death and incidences of crop damage, their causes and seasonality. Monetary value of livestock loss was obtained thorough the market price of the livestock type, age and sex for pack animals, cattle, sheep and goat.

The monetary benefits accruing to the local community living inside the HNP, was generated through the questionnaire survey, results of which are presented in chapter 4, on resource dependency. The monetary benefit obtained from tourism is taken as the benefits received by the local community of HNP, from non-consumptive resource use.

Loss/benefit was calculated for individual household using the following formula:

Predation value per household = $\sum\{[n(\text{Livestock type})] \times \text{Market price}\}$

Benefit per household = (Tourism income) > (Predation value) per household

Loss per household = (Tourism income) < (Predation value) per household

Village hamlets were divided into distance categories: <1 km; 1-10 km; 11-20 km and > 20 km, to explore if distance from the metalled roads had any bearing with the wildlife related loss and benefits. Descriptive statistics, univariate and bivariate analysis were carried out using SPSS 16.0 to explore the relation between variables.

5.3 RESULTS

5.3.1 Livestock holding pattern

Cattle and pack-animals were owned by 81% of the households, which was followed by local cattle (dzo/dzomo) with 80% households owning them. Goats and sheep were owned by 64% and 72% households, respectively (Figure 5.2). Livestock holding pattern reveals that the livestock that fulfils subsistence needs and provides income to the household were the ones kept most. The total livestock holding of 16 village hamlets of the study area was found to be 3650, with average livestock holding per household to be 33.8 ± 43.46 . Goat (41%) and sheep (34%) formed bulk of the livestock holding while yak (0.35%) formed the least, with 13 yaks for 108 households (Figure 5.3). Highest mean livestock owned per family was found to be for goat (13.87 ± 25.05), followed by sheep (11.77 ± 18.05), pack-animals (horse and donkey) (3.86 ± 3.21) and cattle (2.08 ± 1.99).

Percent of families owning pack-animals, goats and sheep increased with increase in distance from the road. All the families in distance of 11-20 and > 20 km owned pack animals (Figure 5.2). Significant difference was found in the mean livestock holding for the households from four village clusters [$F(3,104) = 8.675$, $p \leq 0.000$], as well as for the households depending on distance class. Those farthest from the road had the highest mean livestock holding (65.96 ± 50.69) as well as highest mean of sheep, goat, and pack-animals (Figure 5.3).

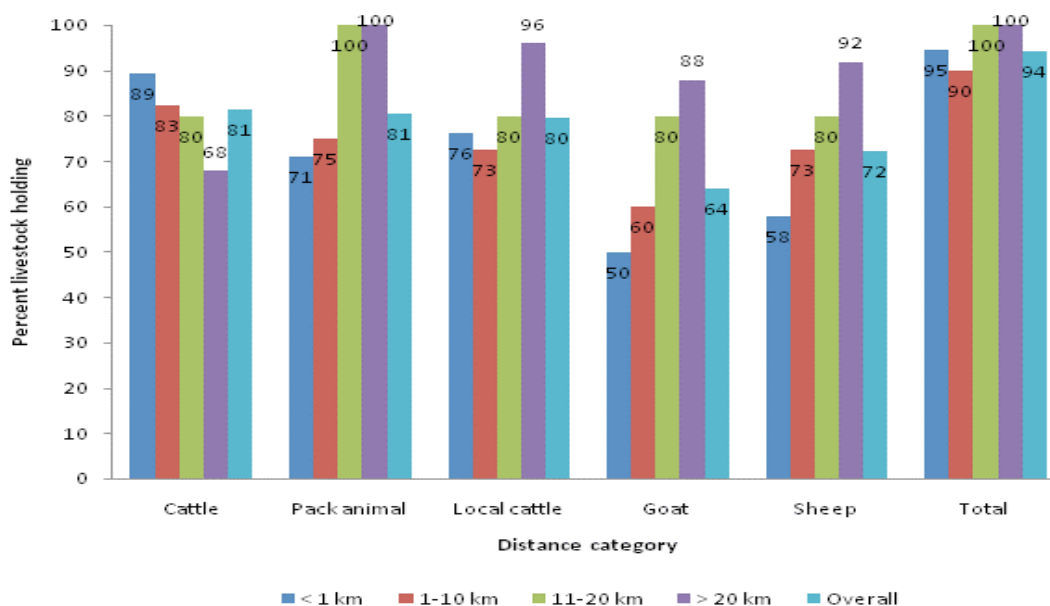


Figure 5.2: Livestock holding pattern across the village hamlets in four distance categories (n = 108)

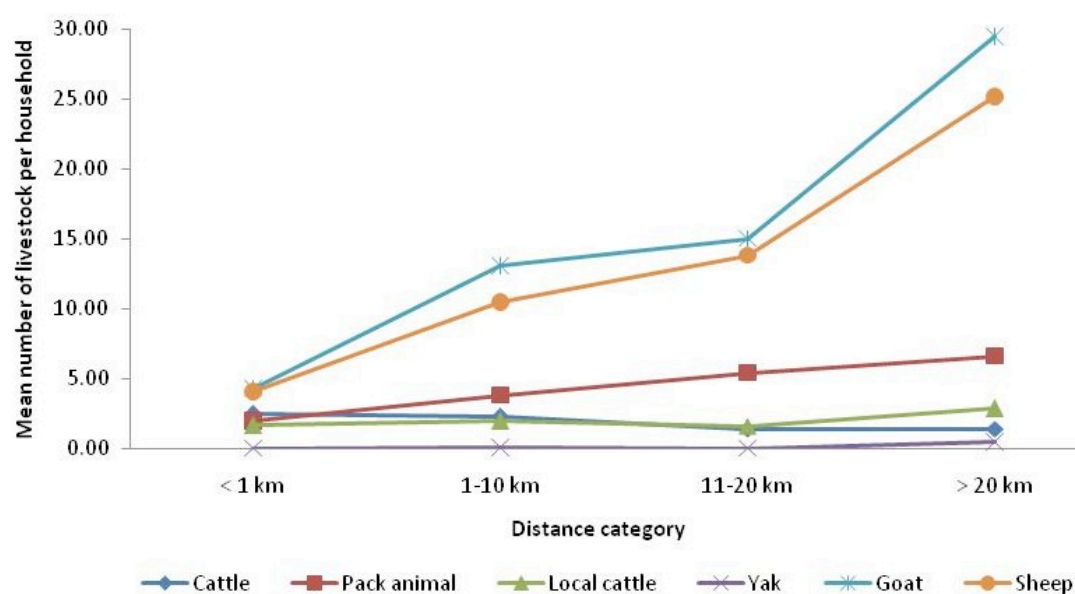


Figure 5.3 Mean livestock holding per households along the distance categories, in the village hamlets of HNP, Ladakh

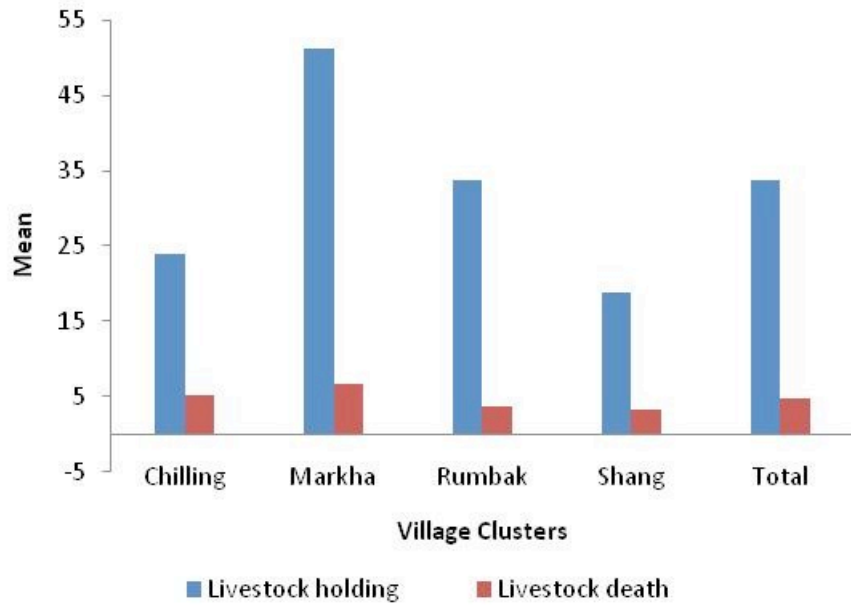


Figure 5.4: Mean livestock holding and mean livestock death in the village clusters of HNP (n = 108)

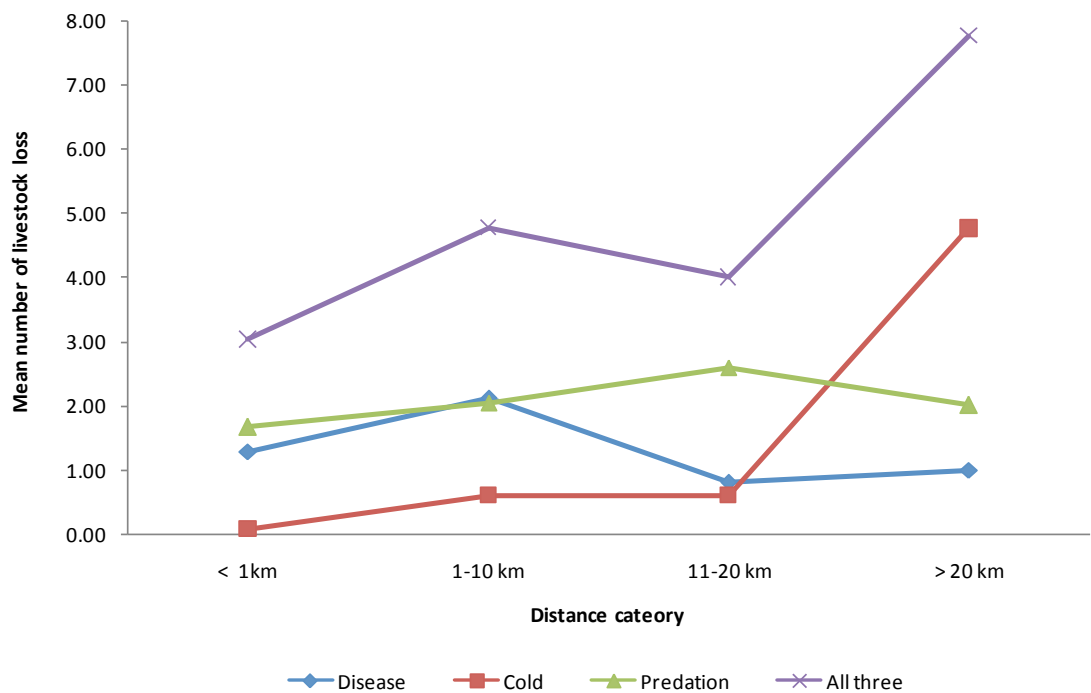


Figure 5.5: Mean livestock loss per households, due to disease, cold and predation by wild carnivores in the village hamlets of HNP along the distance categories

5.3.2 Livestock loss

5.3.2.1 Causes of livestock loss

Of the 108 households sampled, 58.3% of households reported predation by wild carnivore as a reason of livestock loss, 41.7% reported livestock death due to disease and 19.4% reported extreme cold conditions in the month of June-August 2006, accompanied by heavy rainfall and snow, to be the cause of livestock death (Table 5.1). An annual loss of 4.81 ± 6.47 livestock head per family was recorded for the study area. One-way ANOVA revealed significant difference in the mean livestock loss per family among distance categories [$F(3,104) = 2.859$, $p \leq 0.05$], where highest loss, due to all three factors combined together, was noted for families living farthest (7.76 ± 8.83) from road (Figure 5.4).

Table 5.1: Causes of livestock mortality, at various distance from metalled road in HNP (n = 129)

Livestock death cause	< 1 km	1-10 km	11-20 km	> 20 km	Total
Disease	17 (37.8)	18 (40)	2 (4.4)	8 (17.8)	45 (41.7)
Cold	1 (4.8)	5 (23.8)	1 (4.8)	14 (66.7)	21 (19.4)
Predation	20 (31.7)	26 (41.3)	4 (6.3)	13 (20.6)	63 (58.3)
All	38 (29.5)	49 (38)	7 (5.4)	35 (27.1)	129 (100)

Figures in parentheses represent percent

A total of 520 livestock deaths (14.2 % of the total livestock holding) were reported for the period of August 2005 to September 2006. Of this 208 livestock (40%) were reported to be predated by wild carnivore, 163 (31.3%) were reported to be dead due to disease and the remaining 149 (28.7%)

deaths were attributed to extreme and unpredictable cold conditions. Mean loss of livestock due to disease, cold and predation was found to be 1.51 ± 3.1 , 1.38 ± 4.1 and 1.93 ± 3.1 respectively (Table 5.2). Bovines constituted 82% of livestock predated by the wild carnivores, and were lost more in comparison to the large body livestock, but they were lost in proportion to their relative abundance (Table 5.3).

Table 5.2: Livestock deaths reported for period between August 2005 to September 2006 by the residents of HNP, Ladakh

Livestock		Cattle	Pack-animals	Bovines	Total
Death due to	Disease	14 (2.6)	15 (2.8)	134 (25.8)	163 (31.3)
	Cold	9 (3.9)	1 (0.19)	139 (26.7)	149 (28.6)
	Predation	36 (10.4)	18 (3.5)	154 (29.6)	208 (40)
Total death		59 (11.3)	34 (6.5)	427 (82.1)	520

Figures in parentheses represent percent

Table 5.3: Relative abundance and loss of livestock in HNP, Ladakh

Livestock	Cattle	Pack-animals	Bovines
Relative abundance	12.57	11.56	75.86
Relative loss	11.34	6.53	82.11
Ratio of relative abundance to relative loss	0.9	0.56	1.08

5.3.2.2 Seasonality of livestock loss

Death of livestock due to disease was most common in winter season, where 45.9 percent cases were reported, which was followed by summer and spring seasons. Extreme and unexpected cold and moist conditions in the

month of June-July 2006 were the major cause of livestock loss due to cold conditions in the summer months, amounting to 78.3% death in summer. This loss occurred when the livestock were taken to summer pastures, located at higher altitudes, where livestock are kept in an open enclosure, made up of stone wall, and hence have no protection against natural calamity as well as predation. Predation by wild carnivore was almost similar in winter, spring and summer, and it was least in the month of autumn where only 15 percent livestock loss was reported (Table 5.4).

Table 5.4: Seasonality of livestock mortality due to various causes in the HNP, Ladakh

Season	Disease	Cold	Predation
Winter	45.9	17.4	25.9
Spring	24.3	4.3	29.3
Summer	27	78.3	29.3
Autumn	2.7		15.5

5.3.2.3 Predator species and place of predation

Of the two major wild carnivore species in the region, loss of livestock due to predation was mostly attributed to Snow leopard (70.3%), only in 4.7% cases predator was not identified (Table 5.5). Remaining loss of livestock was due to wolf and wild dog, but this loss also includes those cases where the livestock was injured only. Goat and sheep were mostly preyed by Snow Leopard followed by Tibetan Wolves. Cattle were mainly hunted by Snow Leopard. Pack animals were killed more by the wolves and snow leopard or wolf. Feral dogs lifted small-bodied livestock only (Table 5.6).

Table 5.5: Percent livestock killed by various predators

Predator	Frequency	Percent
Snow leopard	45	70.3
Wolf	6	9.3
Either	9	14.1
Don't know	3	4.7
Dog	1	1.6
Total	64	100.00

Table 5.6: Livestock prey type and predator species (n =64)

Predator	Bovine	Cattle	Pack-animals
Snow leopard	77.8	88.2	27.3
Wolf	2.8	5.9	36.4
Snow leopard &/or Wolf	16.7	5.9	36.4
Feral dog	2.8		

Of the 63 cases of livestock being predated or injured by wild carnivore, most of the incident took place in summer pasture, followed by 30% incidents reported from village and 20.6% at winter pastures (Figure 5.6).

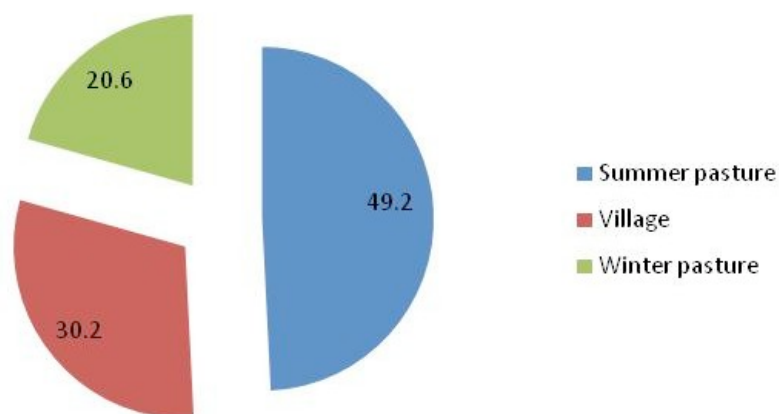


Figure 5.6: Percent incidence of place of livestock predation

5.3.2.4 Preventive measures

The households were found to employ methods ranging from herded guarding, shepherd dogs and predator proof corrals, at the summer pastures and villages. Only 20 households were found to be using corrals, of which 90% found them useful. Guarding herds and shepherd dogs were not useful for 48% of the households. Lack of manpower to guard and tend the herd was cited as the main problem, by almost 70% of the respondents.

5.3.3 Crop damage

5.3.3.1 Cropping pattern

In an agro-pastoralist system, both livestock and agriculture are the mainstay of the local economy and both these face threat from the wildlife of the area, where there is close interspersed of human system and the wild habitat. Grazing of the domestic ungulates in the habitats preferred by the wild ungulates drives the wild herbivores away from the pasture lands and hence in search of green fodder they often come down to the agriculture fields and damage the crop. This is a serious damage to the local subsistence economy, where the crops are grown on the onset of the limited growing period, with limited resources – fertile, arable land, water and human labour. Agriculture in the Ladakh region is mainly subsistence type where three major crops are grown in the beginning of summer season. This growing season also coincides with the melting of snow at lower reaches/elevation and hence wild ungulates move from higher elevation to lower reaches. Often the wild ungulate get lured by the small succulent crop, which causes damage to the crop and hence results in retaliatory measures by the villagers. Crop

depredation in the region by wild ungulate is almost an annual phenomenon, but in the summers of 2006, heavy rains followed by landslides also resulted in crop loss, as well loss of agriculture land, orchard and camping sites (Plate 6).

5.3.2.2 Causes of crop damage

Of 108 households, 73 (91%) reported crop damage, of which 86% was attributed to wild ungulates and 13.7% due to landslides and unprecedented rains in the area. All the households from the hamlets located far from metalled road, reported crop being damaged by the ungulates (Figure 5.7). For 2006-07, rain-slide was reported as the main reason of crop damage by the households located near the road.

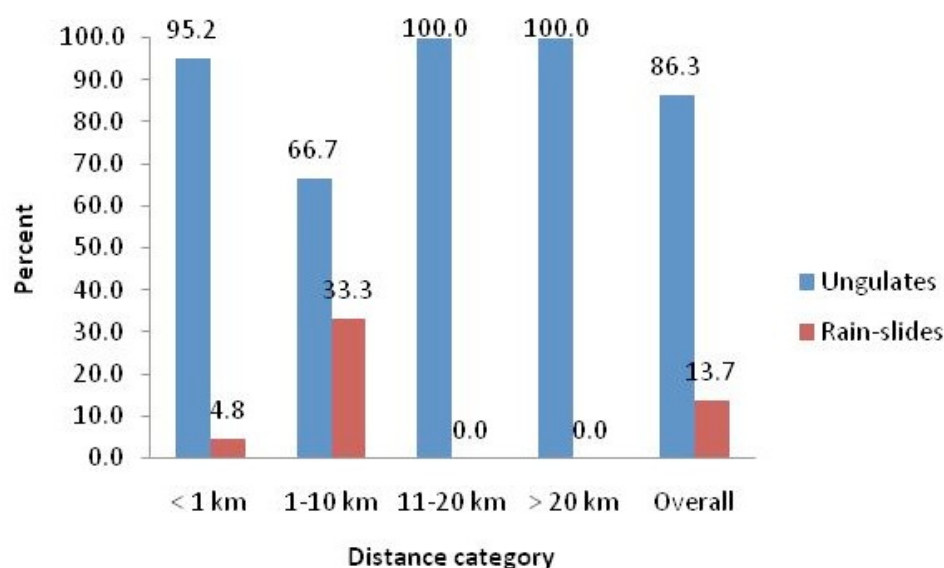


Figure 5.7: Percent households reporting crop loss (n = 73)

Besides causing damage to the agriculture fields, heavy rains also damage the orchards and the camping sites. Crop depredation was reported to be an annual phenomenon by the respondents. It was observed that

residents put more efforts, in terms of labour, time, quality of seed and manuring to the fields located near their dwellings and they were the fields which reported less or no crop depredation as compared to the fields which are located far away from the villages. Guarding one's field located at quite a distance from the village is also a reason that many have either abandoned their fields at far places or have shifted their home near to the field. Some households have their summer homes in the valleys where they grow crops in summer and hence live near to the field in the cropping season to guard their field until it has been harvested.

5.3.2.3 Seasonality of crop loss

Crop depredation was highest in the month of April-May when the crop is tender and is preferred by the ungulates. But due to many reasons people were not able to guard their crop. Season of tending the crop coincides with the tourism season, hence, mostly women and old men participate in agricultural work and other young male of the households get engaged in tourism activities. Lack of helping hands at home is one of the major reasons, as most of the young people are out of their houses to study and work in Leh or any other nearby village. Many a time agriculture fields are also located at quite a distance from the houses and hence people are not able to guard them all the time. Wild ungulate depredate crop fields either very early morning or late in evening and both the times are very inconvenient for the villagers. Those who are left in villages for agriculture are mostly women and old people, the other members of the family come to help at sowing time or harvesting season, from their respective work or study places.



(a) Crop damage due to wild ungulates in Rumbak, HNP



(b) Crop damage due to rain slides: the agriculture land washed away in Markha valley, HNP

PLATE 6

5.3.2.4 Preventive measures

Measures adopted to reduce crop depredation by wild ungulates were rarely observed, fencing of the agriculture crop using the barbed wire was seen only in the village of Rumbak and some reported keeping dogs for guarding the fields, but they always accompanied the owners to the fields. Constructing scare-crow, use of stone catapult and making fire were reported as the measures for preventing crop damage, by ungulates. But efficiency of these measures is limited, as agricultural crops are small and scattered, with limited work force, to tend the agricultural crops. Preventive measures were used intensively in the fields close to the village hamlets. Since loss of crop was more from the unattended fields, where lesser inputs have gone, so respondents were not able to tell the loss in monetary terms.

5.4 ECONOMICS OF HUMAN ANIMAL INTERACTION

The communities living inside the HNP, incurred loss due to livestock predation and crop damage. However, damage to the crop was not considered significant, as most of the damage took place in the fields away from the villages, where agriculture intensity was less. Moreover, the ungulates mostly damaged the crops when the crop was young and small, therefore productivity was not affected much. Productivity from the fields also varies from year to year and hence respondents were not able to quantify crop loss.

Table 5.7: Total annual monetary value (INR) of predation as percent of total income and tourism income along distance categories from metalled road, in HNP

Distance from metalled road	Predation value (INR)	Percent of total income	Percent of tourism income
< 1 km	2,54,000	9.2	52.7
1-10 km	3,80,000	9.4	29.3
11-20 km	64,000	21.9	25.3
> 20 km	4,30,000	22.4	35
Total	11,28,000	12.5	34.6

For the purpose of analysis, market price of the livestock was used to obtain the cost of living with the wildlife. Total monetary loss due to predation was found to be 12.5% of the total income and 34.6% of the tourism income. Monetary loss as percent of total income increased with increase in distance from metalled road (Table 5.7), signifying that contribution of tourism was high in these village hamlets. Share of tourism income to the total income is lowest for the village hamlets located near the metalled roads and hence predation value as percent of tourism income is highest for them. The income derived from tourism was taken as the benefit obtained from living with the wildlife.

Table 5.8: Total annual monetary value (INR) of predation as ratio of total income and tourism income along distance categories from metalled road, in HNP

Distance from metalled road	Predation value/total income	Predation value/tourism income
< 1 km	0.19	1.11
1-10 km	0.14	0.45
11-20 km	0.27	0.31
> 20 km	0.4	0.62
Total	0.21	0.6

Since, higher percent of people living near metalled road, were not involved in tourism, and obtained more income from other sources, the ratio of predation value to tourism income was highest for them, but the ratio of predation value to overall income was lowest. The ratio of livestock predation value to benefit (tourism and total income) was noted next highest for people living farthest from the metalled road, signifying greater per household monetary losses to them then to people living at 1-10 km distance from metalled road (Table 5.8).

Table 5.9: Percent of households along distance categories from metalled road, in HNP incurring benefits and losses due to wildlife presence in the HNP (n = 108)

Distance	Benefit	Loss	None
< 1 km	31.6	44.7	23.7
1-10 km	67.5	17.5	15
11-20 km	100	0	0
> 20 km	84	12	4
Total	60.2	25	14.8

Figures in parentheses represent percent

Kruskal-Wallis test revealed significant difference in the percent households incurring benefits or loss from four distance categories ($\chi^2=22.090$, $df=3$, $p \leq 0.001$) (Table 5.9). Of 72 households dependent on the park's resources, 60% households were found to be obtaining higher returns from tourism income from HNP compared to the losses associated with livestock predation. One-fourth of the households (25%) reported losses (more predation value than income from tourism). Of these only 7 households were involved in tourism activities and thus earned tourism income and while another 20 households obtained no tourism income from resource, but did suffer losses due to wild predators.

Mean monetary value of predation associated loss, tourism income, loss and benefits accruing to the households from wildlife were found to increase with increase in distance of the village hamlet from the metalled road. One-way ANOVA revealed significant difference in the mean monetary benefit obtained [$F(3,104) = 4.818, p \leq 0.001$], mean tourism income [$F(3,104) = 9.624, p \leq 0.001$], for different distance class where highest mean income and benefit was noted for households in village located at 11-20 km. Whereas, highest monetary value of predation was noted for village hamlets located at more than 20 km from metalled road.

Table 5.10: Mean monetary value of predation, tourism income, benefit and loss for village hamlets located at different distance category from metalled road in HNP, India

Distance	Predation value (INR)	Tourism income* (INR)	Benefit* (INR)	Loss (INR)
< 1 km	14,111 ±12,597	12,684 ±23,237	11,618 ±21,428	5,618 ±9,803
1-10 km	14,615 ±16,294	32,400 ±32,681	25,750 ±30,661	2,850 ±9,235
11-20 km	16,000 ±13,441	50,400 ±12,803	37,600 ±25,148	0
> 20 km	30,714 ±36,889	49,120 ±28,855	36,440 ±29,631	4,520 ±17,361
Total	18,193 ±22,329	30,166 ±31,343	23,800 ±28,676	4,078 ±11,582

Benefit = (Tourism income > Predation value);

Loss = (Tourism income < Predation value)

**Significantly different at $p \leq 0.001$*

5.5 AWARENESS AND ATTITUDES TOWARD HNP AND WILDLIFE

About one-fourth of the HNP residents (23%) knew about the National Park status of the area. Significantly larger percent of respondents (32%) who were involved in tourism knew about the protected status of the area, compared to those who did not get any income from tourism (6%) ($\chi^2 = 14.24$, $df = 2$, $p \leq 0.001$) (Table 5.11). Only 7% respondents viewed receiving benefits from the national park, while 19% perceived losses (Table 5.12). Almost half (53.7%) of the respondents viewed that wildlife increased in the area, while 36% did not know about the status of wildlife and 2% reported that the wildlife number has been constant for last 10 years. More percent (17%) of younger respondents (> 30 years) viewed obtaining benefits from wildlife compared to 7% older population (< 60 years) (Table 5.11).

Table 5.11: Attitudes and awareness of respondents towards HNP and wildlife (n =108)

Variables		Aware of existence of HNP (%)	Wildlife beneficial to you (%)	Has the wildlife population in your area increased (%)
Gender	Male	30	6	49
	Female	12	10	62
Engaged in tourism	Yes	32	75	54
	No	6	25	53
Age	< 30	28	17	50
	30-45	24	0	57
	45-60	32	12	56
	> 60	11	7	50
Overall		23.1	7.4	53.7

Table 5.12: Difference between actual and perceived losses and benefits accruing to the households within HNP (n =108)

Losses		Benefits		Neutral	
Actual	Perceived	Actual	Perceived	Actual	Perceived
25	19	60	7	15	35

*Actual loss = tourism income < monetary value of predation;
Actual benefits = tourism income > monetary value of predation*

5.6 DISCUSSION

Livestock holding pattern for the present study was observed similar to that found by Bhatnagar et al. (1999). Sheep and goat formed the bulk of livestock holding, yaks were rare, 95% households did not own them, this percent was higher than that reported by Bhatnagar et al. (1999), suggesting that yak are becoming less popular as the domestic livestock. Loss of livestock was mainly attributed to cattle predation, followed by disease and extreme cold conditions. Percentage of families reporting livestock predation for the present study (58.3%) was higher than 50.6% reported by Bhatnagar et al. (1999) and lower than 90.7% reported by Jackson et al. (2003). Bhatnagar et al. (1999), provided depredation loss for 79 households, compared to the 108 households for the present study, which could be the reason for higher livestock loss for the present study. The study by Jackson et al. (2003) was conducted in 2002, after which the corral improvement program (predator proof corral) was launched in the study area. Due to improved corrals, livestock predation from corrals accounted to only 4.46% of livestock loss in 2005-06, compared to 12.3% in 1998-99 (Bhatnagar et al. 1999). Most of the livestock loss was reported from the settlements located at more than 20 km from metalled road for the present study, similar findings were observed by Bhatnagar et al. (1999). Large number of small-bodied livestock present in these village hamlets, and also a good population of Snow leopard and Wolf in the area, could be the cause of high livestock mortality in these hamlets. Livestock loss reported for this region by present study was higher than that reported for Bhutan, where only 2.3% of the livestock was

reported to be predated by the wild carnivore (Wang & Macdonald 2006), as prey species in present species was Snow leopard and they are known to kill large herd of sheep and goat at one time.

Mean livestock predation per household due to predation (4.81) was lower than reported by Bhatnagar et al. (1999) (6.2), and higher than reported by Mishra (1997a) for Kibber wildlife sanctuary (1.6). Mean livestock holding per family was found to decrease, from 50.3 (Bhatnagar et al. 1999) in 1998, to 33.8 in 2006 (present study). The monetary value of the livestock loss per household was found to be higher than that reported by Bhatnagar et al. (1999). Despite lesser number of livestock being predated, increased monetary value of the livestock over a period of eight years could be the reason for higher monetary loss for the present study. The monetary value of predation per household (INR 18,193) was found to be greater than that reported by Wang & Macdonald (2006). However, the loss as percent of total income was lesser (12.5%) than reported by Oli et al. (1994) for Nepal (25%), Mishra (1997a) for Kibber wildlife Sanctuary, India (52%), and Wang & Macdonald (2006) for Bhutan (17.9%). Livelihood diversification, as in the present study provides more income sources and higher income, thus providing higher insurance towards monetary loss due to predation.

Livestock was more vulnerable in winter season to disease as well as predation. Though predation took place in other seasons as well, but was significantly low in autumn. There was no significant difference in predation in summer pastures, winter pastures and in the village. In most of the cases

predation took place at night time, especially in the winter pastures and the village. Similar findings were made by Bhatnagar et al. (1999).

Loss of crop to wild ungulates was found to be substantial and was reported to be an annual incident. A little more than 90% of the households reported crop damage due to ungulates or the rain slides. 86% households attributed crop damage to ungulates, compared to 96% reported by Jackson et al. (2003). Most households reporting crop loss were located away from the trek trails and their neighbourhood provided good habitat for the wild ungulates. An added factor of unprecedented rains in summer months during 2005-06 was reported to be the main cause of crop loss. Many respondents informed that since crops were predated by wild herbivores on regular basis so they have become habitual of that loss, but the crop damage due to rains was unexpected. Villagers knew the places more susceptible to crop depredation and therefore they had either stopped growing the crops in those land or they would leave the crop after sowing on the mercy of god. Some also shifted their houses to the fertile agriculture lands for guarding their crops and many had summer houses where they stay for the entire duration of agriculture cycle to protect the crops.

Negative human-wildlife interactions are reported to increase in India due to increasing human population, resulting demand of resources, loss of natural habitats and increasing wildlife populations (Rodgers 1988; Saberwal et al. 1994). Increased negative interaction is seen as a response to increase in livestock population and also the change in agriculture and animal

husbandry practices (Mishra 1997a). Killing of livestock and crop loss are not new phenomenon in the HNP, they have been reported earlier as well (Bhatnagar et al. 1999, Jackson et al. 2003). But now since the Jammu & Kashmir Wildlife Protection Department have stopped giving compensation to the livestock kill and the crop loss (personal communication with Chief Wildlife Warden, Leh) there has been a decrease in the number of cases reporting livestock loss and crop predation as well. People harboured a neutral attitude towards the wildlife and the conservation issues especially that of declaring the national park, though their economy has been affected by declaration of the national park, but unlike other national parks, their rights of collection and movement have not been curtailed in the present study area. A shift has been observed in the economy of the residents, as it is becoming more and more tourism oriented.

Livestock predation and crop damage results in monetary loss and other associated losses of labour, time and other goods and services. This loss affects the attitude of the local residents. Due to major costs associated with livestock tending and agriculture production, the younger generation prefers to opt for those economic activities which promises them better income gain and less time spent on the activity, as is evident from the study. The overall benefit was found to be greater than the losses for 60% of the households. Loss was significant to those who did not obtain any income from the non-consumptive resource use (tourism in this case), but still the loss constituted 34.6% of the income earned from resource use and 12% of the total income. Tourism constitutes 36% of the total income and in absence of

any tourism income, the loss would amount to 19.6% of the total income. Share of tourism income in total income increased with increase in distance from metalled road and the livestock loss in absence of any tourism income amounts to 62% for those living farthest from the metalled road. Hence tourism is emerging as one of the most lucrative offer for the younger generation, since it provides monetary support in case of livestock loss. Almost half of the younger respondents were engaged in tourism activities (50%) obtaining direct monetary benefits of tourism, they viewed wildlife as benefits and at instances they even reported the wildlife as the “mountain jewels”.

The shift in economic condition and occupational pattern in the study area can be seen as a positive sign for successful conservation of wildlife, but tourism – the main factor for changing economic set-up should not be left unguarded as the region is vulnerable and is also habitat to the most vulnerable and endangered species. Regulated tourism plan needs to be made for the region, to counter balance the booming economy of the residents, and the wildlife habitat.

5.7 SUMMARY

Focus group discussions, semi-structured interviews and literature review revealed that the local communities living inside the HNP incur losses in form of livestock predation due to Snow leopard and Tibetan wolf and crop damage due to wild ungulates. To assess the losses incurred by the local community questionnaire survey was carried out during 2005-06 in the human

settlements inside the HNP. The livestock predation study revealed that of 108 households sampled, 58.3% incurred losses due to predation, 41.7% suffered livestock death due to disease and 19.4% reported extreme cold conditions in the month of June-August 2006, as the causes of livestock death. An annual loss of 4.81 ± 6.47 livestock head per family was recorded for the study area. Highest loss, due to all three factors combined together, was noted for families living farthest from metalled road [$F(3,104) = 2.859$, $p \leq 0.05$]. Snow leopard was the predator in 70% instances of livestock predation. Most of the livestock predation (49%) was reported from summer pastures. Only 20 households were found to be using corrals, of which 90% found them useful.

Crop damage in the HNP was attributed to wild ungulates (86%) and to landslides (13.7%). All the households located far from metalled road reported crop damage by the ungulates. Crop depredation was highest in the month of April-May when the crop is tender. Small and scattered agricultural fields make guarding either by self or by guarding dogs inefficient.

The monetary loss due to livestock predation amounted to 34.6% of the tourism income and 12.5% of the total income. Monetary loss as percent of total income increased with increase in distance from metalled road. Highest monetary value of predation was noted for village hamlets located at more than 20 km from metalled road. The main source of income for the households in this category is livestock and tourism hence livestock predation makes them more vulnerable to livestock predation losses.

Of 72 households dependent on the park's resources, 60% households obtained higher returns from tourism income compared to the losses associated with livestock predation ($\chi^2 = 22.090$, $df = 3$, $p \leq 0.001$). For a large percent of households (60%) tourism income was able to off-set the predation losses. The highest percentage of households (45%) for which predation losses could not be off-setted were from villages located near the metalled roads. Since these households were either not obtaining significant tourism income or obtained no tourism income.



Chapter 6

ROLE OF EDUCATION SYSTEMS IN ADDRESSING CONSERVATION ISSUES¹

6.1 INTRODUCTION

The very basic aim of attaining or imparting education is to develop skill and behaviour necessary for survival (Tuncer et al. 2007). Education is the key factor for knowledge acquisition, value formation leading to behavioural and lifestyle changes especially in context of environment sustainability and conservation. Traditionally, life skills (education) were taught as way of life, in societies world over. Norberg-Hodge (1991) noted advent and rampant copying of non-contextual westernized model of education is making the societies poorer by teaching people around the world to use the same resources, ignoring those of their own environment. By teaching same resource skill, the modern education has created artificial scarcity and induced competition. With the growing need for environment education all over the world local specificity of such education has also being emphasized since 1980s (UNESCO 1977, 1980, 1997), as it is now universally accepted that relevance of the Environmental Education (EE) to the local biophysical and social environment determines its success to ensure sustainable human actions. Learning local level environmental issues has been identified as an important challenge in recent years.

¹ *Part of this Chapter appears as research article: Barthwal-Chandola & Mathur (2012) (Appendix I)*

Changes in the education curricula to include environment education and local context, worldwide (Gayford 1996, Education Queensland 2001, Barraza & Walford 2002, Makundi 2003) and in India (NCERT 1988, 2000, CEE 1998) are the significant steps towards sustainable ecosystems. The Indian National Curriculum Framework provides an opportunity to include environment concerns in formal education system and the National Curricula Framework (NCF) (NCERT 2005). The NCF (2005) states that basic criteria of environmental validity of science curricula require that science be placed in the wider context of the learner's environment, local and global aspect enabling them to appreciate issues at interface of science, technology and society. One of the principles identified by NCF (2005) regarding approach to knowledge in curriculum is connecting with the local and contextualization in order to situate knowledge and realizing its relevance and meaningfulness.

Greening of school textbooks, under the Strengthening Environment Education in the School System (EESS) programme, was one such major step taken to include locale specific environment issues, after Supreme Court directive in 2003 by Ministry of Environment and Forests (MoEF) with the Centre for Environment Education (CEE) as the nodal agency. As part of EESS, greening of the school textbooks in Grades 6, 7 and 8 have been piloted in eight Indian states, including the state of Jammu & Kashmir (Ravindranath 2007).

Ladakh represents an interesting case, where like other mountain societies, till 1860's education in Ladakhi society largely took place in the

villages, in the fields and by the family hearth (Norberg-Hodge 1991, Mingle 2003). Education had no formal meaning for the Ladakhi society (Norberg-Hodge 1991), till the western education model, to improve literacy and educate was adopted for Ladakh. Efforts to improve literacy rate and education led to increase in number of schools from 72 in 1958 (Nair 1958) to 884 schools at present. Rizvi (1986) and Norberg-Hodge (1991) observed that the modern schooling prevented children from viewing the context in which they live, leading to diminution of traditional values, skills and sustainable lifestyles. The time of realization of diminishing traditional values, skills for Ladakhi society interestingly coincided with the era of emphasis on “Environment Education” in formal and non-formal education system. Under the EESS, school textbooks of J&K State Board of School Education (J&KBOSE), in Grades 6 to 8, were refined to include the EE and local specificity.

The concept of environment education and sustainable lifestyle is not alien to Ladakhi society. Many scholars have observed that nature forms an intrinsic part of the Ladakhi folk tradition, which predominates with the message of maintaining harmony with the nature (Norberg-Hodge 1991, Jina 1995, Koshal 2001). Tolerance of Ladakhi society towards other life forms is attributed to the Buddhism and resource scarcity (Fox & Nurbu 1990, Norberg-Hodge 1991).

Within the given backdrop, this chapter thus aims to examine the role of education systems in Ladakh (formal education and religio-cultural values)

to address conservation issues of the region. The objectives are 1) to critically analyze the textbooks used in the government schools for their ability to address the conservation issues with local specificity; 2) to examine the school teacher's knowledge of and attitude towards wildlife and conservation; 3) to explore if the religio-cultural values are pro-conservation and how are these values depicted and disseminated to the masses?

6.2 METHODS

To examine the existing education systems and religio-cultural values in their ability to address the conservation issues of the region, three approaches, *viz.* content analysis of the text books; scheduled questionnaire survey of the government school teachers and informal talks with the religious leaders were used.

Content analysis of government school textbooks was carried out to explore ability of the present formal education system to address conservation issues of the region. Content analysis was used as an approach as it involves documentary research of any form of physical communication, *viz.* journals, films, books, articles (Burrus-Bammel et al. 1988) and is often used for measuring certain phenomenon in the text (Nytell 2003). Content analysis of science and geography textbooks of middle school (class V to VIII) of the J&KBOSE, used in the government schools of Ladakh was carried out.

While carrying out content analysis answers to following questions were sought: Do the textbooks provide information on environmental issues,

including conservation? Are locale specific examples provided in them aiming at better understanding of the local conservation issues? Do these examples provide the local socio-ecological linkages, for the teachers and students to interpret in their ecological set-up context?

Presence of information on environmental issues; global examples; local specific examples; provision for interpretation in context of local socio-ecological linkages scored 1 each for and the absence of these were noted as 0. Hence, the score ranged 0 to 8 for each parameter. Besides, school teacher's opinion on presence of environment specific issues and local examples in the present and the new textbooks was also noted (Barthwal-Chandola & Mathur 2012).

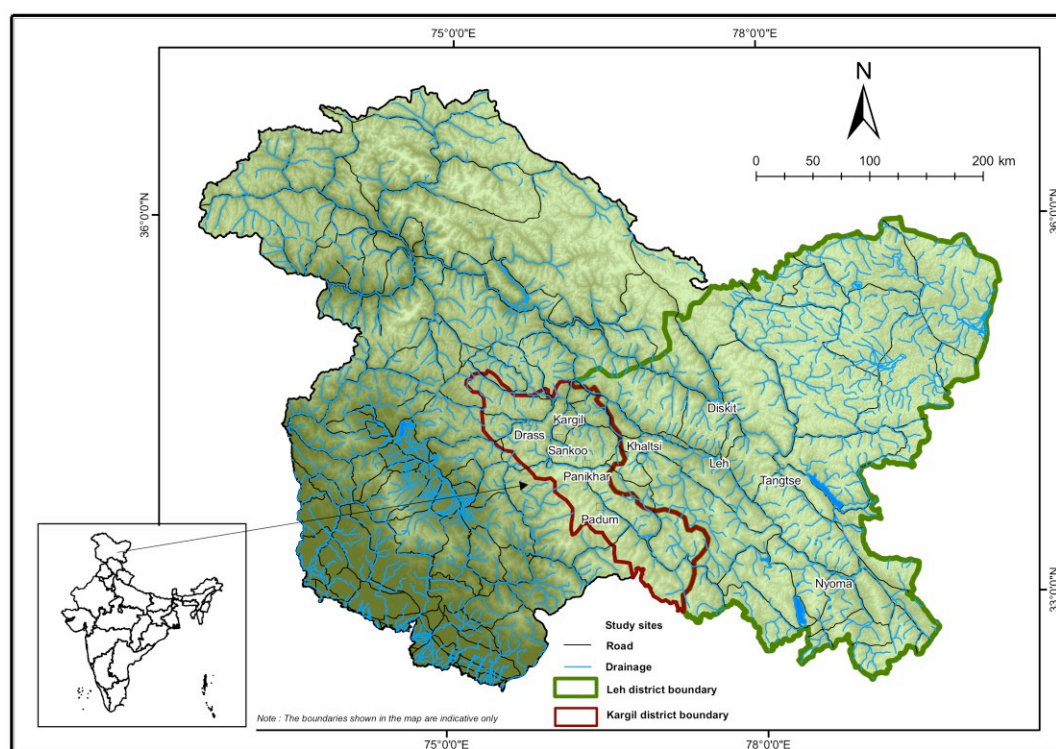


Figure 6.1: Location of the sites in Ladakh where government school-teachers were interviewed

Government school teachers were interviewed (N=277), in Leh and Kargil districts (Figure 6.1) to assess their knowledge and attitudes towards conservation issues. The interview was carried out with the help of self-administered questionnaire schedule, with the aim of answering following: a) What is the ecological knowledge and attitude of the teachers; (b) What factors determine their knowledge and attitude; and (c) Is there any relation between knowledge and attitude?

The questionnaire schedule was divided into three sections. The first section obtained demographic data; the second section explored knowledge of the teachers through a set of 12 statements (Table 6.2), while the third section examined attitude via another set of 12 statements (Table 6.3). All the statements had 'yes' and 'no' responses. Correct answer to the each knowledge statement was given a score of 1. Hence, overall knowledge score for each respondent was obtained by adding correct responses to the 12 knowledge statements. For attitude statements, favorable response (yes) was given a score of 2, whereas the unfavorable response (no) was scored as 1, by adding coded responses for each attitude statement an overall attitude score for each teacher was obtained. The higher attitude score represented favorable attitude, while lower score indicated unfavorable attitude.

The teachers were classified according to gender (male/female), age [young (<34 years)/old ($\geq$ 34 years)], teaching experience [low (< 12.5

years)/high (≥ 12.5 years)], pre-service training underwent (yes/no), education (up to grade 12/university degree), place of education (rural/urban) and resident (natives/non-natives), to see if these influenced knowledge and attitude.

The results were analyzed using descriptive, one-way ANOVA, correlation and chi-sq statistics, via SPSS 16.0.

Unstructured interviews and informal talks with religious scholars (N=30) provided information on the religio-cultural teaching practices dealing with conservation issues in the region. Interaction with local community provided insight into their religious beliefs. Besides, questionnaire survey of the school teachers (mentioned above) also helped in identifying factors responsible for shaping their attitudes. Religious leader, local community and the school teachers formed the basis for seeking answers to following questions: are the religio-cultural values pro-conservation? How are these depicted and disseminated to the masses?

6.3 RESULTS

6.3.1 Content analysis of the textbooks

During content analysis it became evident that some of the chapters in Science and Geography subjects had universal information valid for all the regions. The textbooks provide excellent examples of global issues, but most of these lack Ladakh specific examples and also fails to provide the socio-

ecological context to the teachers and the students of the region. The textbooks scored 100% for the presence of environment issues and global examples in all grades, where level of information provided increased with increase in grade. However in case of local examples and linkages provided, the textbooks scored only 12.5% (Table 6.1). Presence of Ladakh specific information was provided through a single chapter in the geography textbook of grade VII, under the chapter 'Life in the Desert Region'. An error was also noted in this above mentioned chapter, where 'Barasingha' (swamp deer) was mentioned as the name of wild animal found in the region.

Table 6.1: Environment specific content representation in the textbooks of J&K State Board of School Education (J&KBOSE)

Subject	Grade	Environment content	Global examples	Local examples	Socio-ecological linkages
Environment Science (EVS)	V	1	1	0	0
	VI	1	1	0	0
	VII	1	1	0	0
	VIII	1	1	0	0
Geography	V	1	1	0	0
	VI	1	1	0	0
	VII	1	1	1	1
	VIII	1	1	0	0
OVERALL SCORE		8	8	1	1
% of total score		100	100	12.5	12.5

Of 277 school teachers, only 37% articulated that the present textbooks provide enough information on environment and its conservation and 74% school teachers expressed that the textbooks do not provide enough information on Ladakh's wildlife, as is evident from textbook analysis as well.

The views of Ladakh's government school teachers aptly reflect the results of content analysis carried for this study. At the time of this study, a new set of textbooks was being prepared and launched on experimental basis. Most of the school teachers had seen these new set of textbooks and on enquiring on Ladakh specificity in these, 57% felt that these textbooks provided good examples of Ladakh (Table 6.3)

6.3.2 Teachers' knowledge of and attitudes towards wildlife and conservation

6.3.2.1 Demographic profile of respondent teachers

Table 6.2 summarizes demographic attributes of 277 respondent teachers. Overall female representation was 34.5%, however, when gender participation was examined by location, it was found that the female representation was greater in Tangtse, Diskit, Leh and Khaltsi compared to other places. The mean age of teachers was 34 ± 7.76 years with an average of 12.5 ± 9.11 years of teaching experience. Participants from Leh, Khaltsi, Drass and Panikhar were more experienced than those from other places. Most of the teachers (63.8%) had studied up to grade 12, while 36.2% had a university degree. Most of the teachers from Leh (92.9%) had undergone teachers' training as compared to those from elsewhere. Overall, only 41.5% had undergone training. About 57% participants taught science as an individual subject or in combination with other subjects. The highest percent (52.6) of non-native participant teachers was noted for Tangtse.

6.3.2.2 Ecological knowledge of the teachers

Responses to statements about the knowledge of the teachers are summarized in Table 6.3. The knowledge score ranged from 3 to 12, with a mean of 8.11 ± 2.02 . More than half of the respondents (61.3%) scored 8 or more. The knowledge score was dependent on the teachers' teaching experience, education and place of education. Those who had fewer years of teaching experience (8.35 ± 1.91) had higher knowledge score than the more experienced teachers (7.84 ± 2.09) [$F(1,275) = 4.565, p \leq 0.05$]. Teachers who had a university degree (8.76 ± 1.62) scored higher in knowledge than the teachers who had studied up to grade 12 (7.72 ± 2.11) [$F(1,275) = 18.019, p \leq 0.001$] (Figure 6.1).

Table 6.2: Demographic profile of the respondent teachers from ten administrative blocks of Leh and Kargil districts (n =277)

Places		Diskit	Khaltsi	Leh	Tangtse	Nyoma	Kargil	Drass	Sankoo	Panikhar	Padum	Total
Attributes												
Number of Participants		17	29	28	19	20	57	30	22	27	28	277
Male (%)		41.2	48.3	46.4	26.3	100	70.2	100	77.3	81.5	78.6	65.5
Female (%)		58.8	51.7	53.6	73.7	-	29.8	-	22.7	18.5	31.4	34.5
Age range (years)		23-44	22-57	21-52	21-40	22-54	23-52	28-51	25-45	20-56	21-48	20-57
Mean teaching experience (years)		6.4	15.8	15.9	3.6	9.6	13.7	15.6	12.6	15.3	8.6	12.5
Educational Qualification (%)	Up to grade 12	29.4	71.4	82.1	57.9	65	50.9	66.7	81.8	88.9	46.4	63.8
	University	70.6	28.6	17.9	42.1	35	49.1	33.3	18.2	11.1	53.6	36.2
Training undergone (%)	Yes	47.1	51.7	92.9	26.3	50	40.4	56.7	31.8	48.1	32.1	41.5
	No	52.9	48.3	7.1	71.4	50	59.6	43.3	68.2	51.9	67.9	58.5
Subject Teaching (%)	Science	70.6	37.9	21.4	42.1	85	59.6	60	59.1	74.1	75	57.8
	Others	29.4	62.1	78.6	57.9	15	40.4	40	40.9	25.9	25	42.2
Native (%)	Yes	100	69	100	47.4	50	54.4	100	63.6	100	67.9	69.7
	No	0	31	0	52.6	50	45.6	0	36.4	-	32.1	30.3
Place of Education	Rural	41.2	69	89.3	47.4	50	31.6	76.7	63.6	-	-	45.5
	Urban	41.2	20.7	3.6	52.6	50	68.4	23.3	36.4	100	100	51.6
	Both	17.6	10.3	7.1	-	-	-	-	-	-	-	2.9

Higher knowledge score was observed for the teachers with university degree as all of them (100%) were able to tell the correct list of wildlife of Ladakh ($\chi^2 = 31.36$, $df = 1$, $p \leq 0.001$) and 89% of them knew the fact that Ladakh has protected areas ($\chi^2 = 27.12$, $df = 1$, $p \leq 0.001$) compared to teachers educated up to grade 12.

Place of education played an important role in determining knowledge of the teachers. One-way ANOVA revealed significantly higher knowledge score for teachers who had studied in urban locality (8.58 ± 1.75) [$F(2, 274) = 8.725$, $p \leq 0.001$] than those who attained education in rural locality (7.57 ± 2.15) (Figure 6.2).

Table 6.3: Response of teachers to the knowledge statements (n =277)

Statements	Yes (%)
Ladakh's biodiversity is most unique	85.0
Snow leopard is an endangered species	98.3
Snow leopard lives in and around rocky mountains	95.0
Correct list of Ladakh's wildlife identified by teachers	62.0
Correct name of wild animal not found in Ladakh given by teachers	83.2
Ladakh has national parks and wildlife sanctuaries to protect wildlife	70.0
Hemis is name of a famous national park and monastery	61.7
Each and every wild animal forms a part of food web	76.5
Conservation education provides knowledge on wise use of resources	92.5
Old/present textbooks provide enough information on Ladakh's wildlife	36.0
Old/present textbooks provide enough information on environment and its conservation	37.3
The new textbooks provide good examples from locale environment	56.9

6.3.2.3 Attitudinal response of the teachers

In general, a large percent of teachers had favorable attitude (Table 6.3). Teachers' overall attitude score ranged from 17 to 24, and a mean of 20.78 ± 1.25 was observed. More than half of the teachers (62.5%) scored above 20, indicating favourable attitudes. Female teachers (21.12 ± 0.86) held more favorable attitude compared to male teachers (20.61 ± 1.40) [$F(1,273) = 10.063$, $p \leq 0.05$]. Similarly, attitude score for the native teachers (20.82 ± 1.24) was higher than the non-native teachers (19.91 ± 1.31) [$F(1,275) = 6.12$, $p \leq 0.05$] (Figure 6.3).

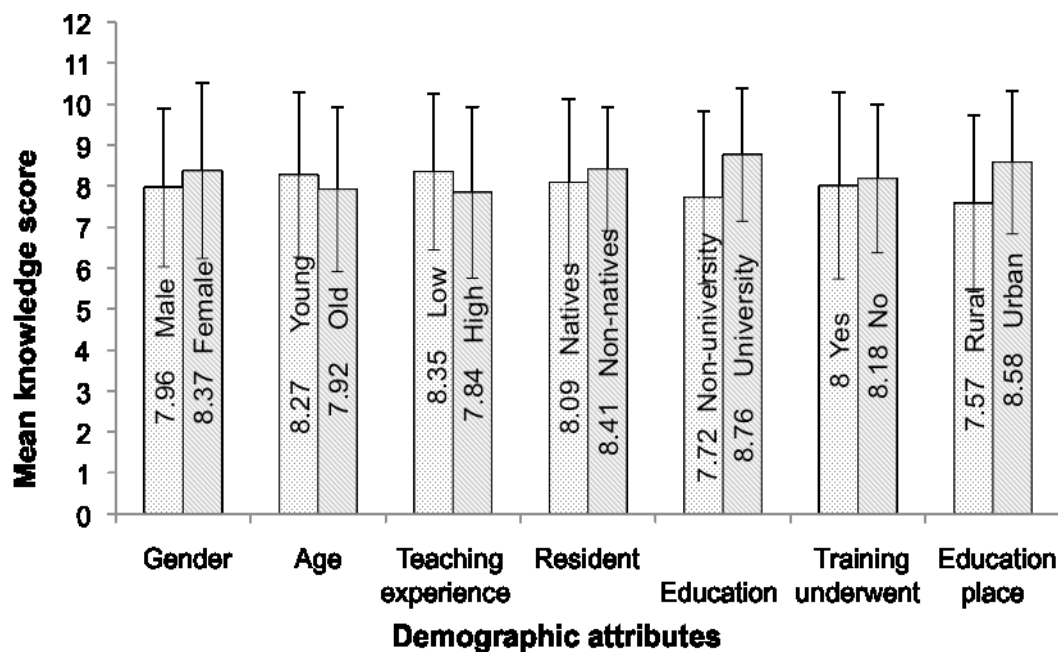


Figure 6.2: Teachers' demographic attributes and mean knowledge score (error bar denotes the standard deviation of the mean)

Table 6.4: Response of teachers to the attitude statements (n = 277)

Statements	Yes (%)
Ladakh's biodiversity is most unique	85.0
Snow leopard is an endangered species	98.3
Snow leopard lives in and around rocky mountains	95.0
Correct list of Ladakh's wildlife identified by	62.0
Correct name of wild animal not found in Ladakh given by	83.2
Ladakh has national parks and wildlife sanctuaries to protect wildlife	70.0
Hemis is name of a famous national park and monastery	61.7
Each and every wild animal forms a part of food web	76.5
Conservation education provides knowledge on wise use of resources	92.5
Old/present textbooks provide enough information on Ladakh's wildlife	36.0
Old/present textbooks provide enough information on environment and its conservation	37.3
The new textbooks provide good examples from locale environment	56.9

Despite high percentage (85.7) of teachers agreeing with the benefits of wildlife, snow leopard was considered a serious threat to people living in the wilderness by three-fourth (74.3%) of the teachers and more than half teachers (55.7%) felt that snow leopard and humans cannot live harmoniously (Table 6.4). Further exploring these statements against demographic attributes, it was found that more natives (76%) perceived snow leopard as a threat than non-natives (42%) ($\chi^2 = 6.95$, $df = 1$, $p \leq 0.005$).

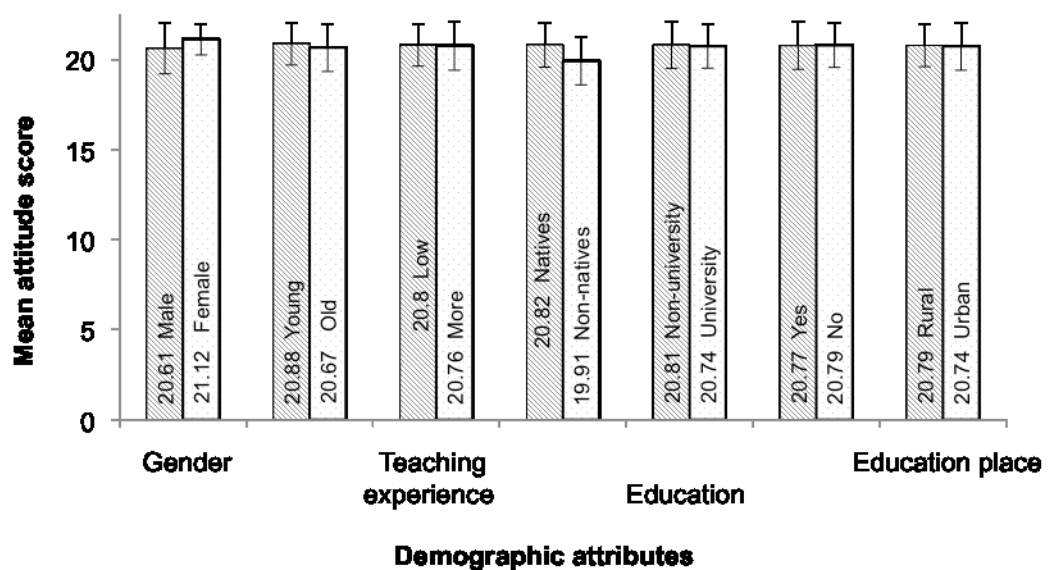


Figure 6.3: Teachers' demographic attributes and mean attitude score (error bar denotes the standard deviation of the mean)

6.3.2.4 Relation between teachers' knowledge and attitudes

Significant positive correlation was observed between the teacher's knowledge and attitude scores. This correlation though weak ($r = 0.242$, $p \leq 0.001$) but do contributes to the literature on positive relation between knowledge and attitude.

6.3.3 Religio-cultural system and values

In absence of modern formal education system in Ladakh, the monasteries alone provided formal education to the monks (Norberg-Hodge 1991). Hence, formal education system was not new to Ladakh, but was rather restricted to the monasteries and monks. However, the religious preaching served as platform for dissemination of the religious philosophy to the masses. These preaching were taken back home, and followed as a way

of life and also instilled in daily lives of the masses. Ladakhi peoples' religio-cultural values are framed by the Buddhism religion, which is followed since 200 B.C. (Norberg-Hodge 1991). The resource scarcity and harsh climate, added with the principal of equality and non-violence against any living being, have been seen as the driving factors of 'self-sustenance' and pro-conservation behaviour, where resources are considered sacred and utilized in a sustainable way. Norberg-Hodge (1991), noted that people consider themselves as part of environment and hence believe that doing anything wrong to the environment would come back to them in form of catastrophe. While, carrying out the study on human-wildlife interaction in the Hemis National Park many a times the researcher was provided with the statements such as

“what will we do, these (wild ungulates) are mountain jewels and we can't kill them. They will eat whatever they will like, but they do leave enough for us”.

Despite one-fourth (25%) of the respondent from the HNP, actually suffering losses, only 19.4% articulated that wildlife causes loss to them, while 26% held neutral attitude towards benefits and losses from wildlife (refer to Table 5.11; Chapter 5). This difference between households actually incurring losses and households perceiving losses could only be attributed to the religious beliefs associated with the local community of the HNP, where they all are Buddhist by religion.

Questionnaire survey of the government school teachers of Ladakh region, revealed a large percentage of respondents (98%) agreeing that natural resources form an integral part of human well-being. Despite high percent of respondent teachers agreeing (74.3%) that snow leopard is a serious threat to people living in remote places, 84.2% also agreed with the statement that conservation of snow-leopard is necessary for human survival (Table 6.4). Apart, from gender defining pro-conservation attitude, the only other factor that explained varied attitude score was the provenance of the school teachers. The native teachers were found to hold more positive attitude score than the non-native teachers (Figure 6.2). These examples from the present study show that religion-cultural values of people from the region were found to be pro-conservation.

Informal interviews with the religious leaders provided insight of the Buddhist philosophy of peaceful and harmonious existence. Plants and animals are used as symbol for religious teachings in form of storytelling. Use of animal symbols, in houses, worship places and monastery takes many forms, from the idols of wild ungulates made of barley flour to the paintings depicting various life forms, on the monastery walls. A common painting appearing on the monastery walls, religious books representing the symbol of interdependence of nature's elements, depict all life forms *viz.*, human, wild ungulate, birds, plants and water (Plate 7). This symbol represents healthy ecosystem, where each and every component is dependent on each other and the survival is threatened when unbalance occurs due to missing life form.

Animal parts are considered sacred in many ways in Ladakhi Buddhist society. Often one could encounter skull of wild ungulate on the “*mane stupa*” and entrance to the house or the entrance to the village (Plate 8), in anticipation that the soul of dead animal would go to heaven and all those who pass through the skull are considered to have traversed through the clean and pure thoroughfare. The horn of dead ungulate is used as vessel during religious ceremonies, where offering is made to God in the hollow of the horns, and that is the reason for observing horns with almost every household in Ladakhi village. These horns are commonly encountered at the entrance to the house. Ibex (*Capra ibex siberica*) is considered superior to all other ungulates. The idol of ibex, “*lha-skin*” is made during the annual festival of “*Lho-sar*” and distributed as the protector from the omen (Plate 9.a). The endangered Black-necked crane (*Grus nigricollis*) locally known as *Cha-thung-thung* is considered a heavenly bird. It is considered and believed that those who do good deeds are able to fly high.

The religious leaders revealed that though Buddhism teaches the philosophy of “*ahimsa*”, and prohibits killing of animal. The follower of Buddhism are forbidden to eat flesh of the animals living in the forests, but has permitted its followers to eat meat provided that they do not see, hear, or suspect that the animal was killed specifically for their own consumption. Trade in flesh is one of the restricted occupations and thus, in Ladakh one would rarely see a Buddhist butcher shop.



Various life forms depicted as paintings on monastery walls

PLATE 7



(a) Ungulate horns kept on entrance gate of the house in HNP



(b) Ungulate horns kept near Rumbak village entrance, HNP

PLATE 8



(a) Ibex idol made from barley flour, kept in the home, Chilling village, HNP



(b) An old stone pit wolf trap, en route the Markha trail, HNP

PLATE 9

The occupation of butcher, fishermen and animal trappers is considered dreadful in Buddhism. Livelihood derived as farmer, tradesman and herder are held in high esteem and these are considered noble occupation. Fox & Chundawat (1988) noted that since, killing of animal is prohibited in Buddhism, the small incidences of livestock killing are considered as favor done by the wild carnivore, where the livestock is left dead and eaten by the people.

The Ladakhi people do not have much choice to balanced and nutritional diet. They have to depend on meat for protein and other dietary requirements. Meat consumption in Buddhist households increases during the winter and is considered ethically more correct than in times of vegetable abundance (Dame & Nusser 2011). However, animals used for consumption are not killed by them.

6.4 DISCUSSION

Individual's knowledge, attitudes and beliefs are formed as a result of education that they get in schools and at homes. The education in school depends on the curricula and the teacher's understanding and grasp of the subject, while at home the child learns the day-to-day skills, most of which are based on socio-cultural and religious beliefs of the society (Figure 6.4).

The findings of the present study suggest that the government school textbooks available to the students of Ladakh, fails to address the local specificity of the environment and conservation issues, nor do they provide

information on linkages to the local socio-ecological process. The results were however not negative altogether for the local context in the textbook. This has been due to the EESS, where some textbooks of Grade 6 to 8 of the J&KBOSE had been taken up for the 'greening of textbook' project under EESS (Ravindranath 2007). As, a result of efforts to provide the local context to the reader of the textbooks, a section on Ladakh has been included in the Geography textbook of Grade 6. However, the errors are noted in the English/common names of the animals referred in the text.

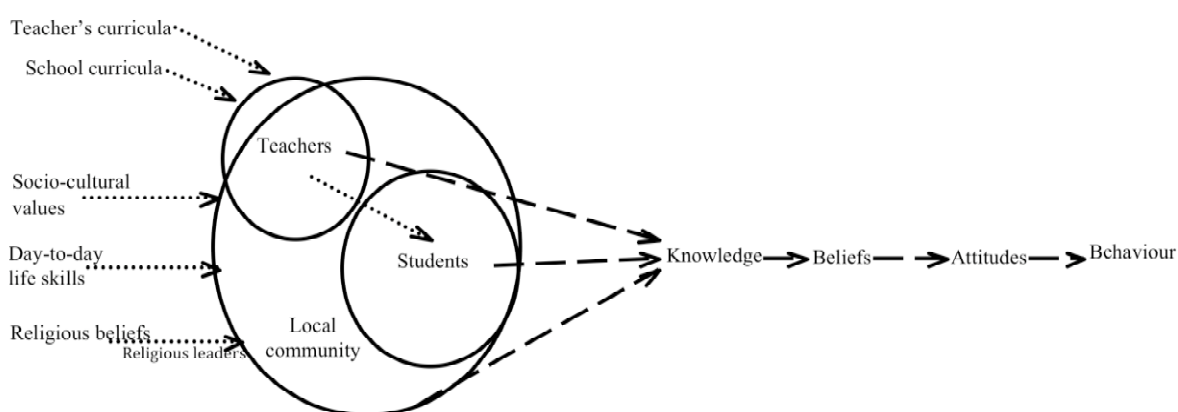


Figure 6.4: Model representing link of formal and other education systems with the community, its sub-components and learning process

Ladakhi teachers on the other hand were found to be aware about the basics of local wildlife and have shown favorable attitudes towards them, except when it threatens their economy, in this case snow leopard, which causes significant economic losses at local level (Bhatnagar et al. 1999).

Ladakh, till recently had little access to higher education, the number of schools were limited to 72 in 1958 (Nair 1958), and hence older teachers tended to not have a university degree. Though the numbers of primary and high schools have increased, yet there is only one degree college in Leh and children go outside Ladakh for university education, which explains the young teachers being more educated and educated in urban settings, mostly outside Ladakh.

The study found that teachers who had university degrees were more knowledgeable. These findings are in conformity with studies by other scholars (Fiallo & Jacobson 1995, Pyrovetsi & Daoutopoulos 1997, Gillingham & Lee 1999, Badola et al. 2012) who have concluded that education is an important factor influencing knowledge. Higher knowledge score was observed for teachers educated in urban locality. Respondents who were educated in urban setting also definitely had a university degree. As studying in urban setting provides ample access to the various sources of information, as well as opportunity for higher education, leading to holistic knowledge and better understanding.

The favorable environmental attitudes shown by female teachers in the present study support findings of Zelezny et al. (2000), Alp et al. (2006), Tuncer et al. (2009). Research conducted elsewhere has shown that females express more concerns about the environment than males irrespective of cultural and educational status (Worsley & Skrzypiec 1998, Eagles & Demare 1999, Tikka et al. 2000, Loughland et al. 2003). Bord & O'Connor (1997)

explain that this difference results from differences in perceived vulnerability to environmental risks. Traditionally women have been closer to nature while performing day-to-day activities, where even providing meals for the family is linked to nature and women perceive changes in environment, affecting their capacity to provide for family.

Though knowledge scores of teachers teaching in Ladakh, were defined by their education level, the attitude score for them were found to be defined by the provenance of the teachers, rather than by age and education. Tanner (1980) and Peterson (1982) suggests that informal education and life experiences with role models such as parents and teachers, are crucial factors in developing the environmental sensitivity of an individual, and hence age and education did not influence attitude of the teachers. Argument given by Newhouse (1990) that favorable attitudes towards environment are perhaps developed on basis of life experiences rather than any educational program holds true for the present study, as native teachers of Ladakh were found to have higher attitude score than the non-natives. Strong background of traditional ecological knowledge reflected in the folk songs and tradition of gathering resources for self sustenance and Buddhist philosophy of peaceful co-existence (Norberg-Hodge 1991, Koshal 2001) explains overall favourable attitude of native teachers. However, closer scrutiny of the individual attitude statements revealed that the native teachers had unfavorable attitudes towards snow leopard. We account this on life experiences of the teachers, where they have grown up in a community, dependent on livestock rearing and any damage to the livestock causes significant economic loss (Bhatnagar

et al. 1999, Wang et al. 2006). Despite this unfavorable attitude, the teachers agreed with the possibility of mutual co-existence, which again can be attributed to the religious teachings.

The region's wildlife is depicted in all forms and from home to monasteries. The animals and plants are considered sacred and get protection against killing and hunting. Evidences exist supporting the protection received to the Black necked crane by the local community of the region, due to the religious linkages of the bird. Pathak (2002) also noted that this bird receives protection by the Buddhist community of the Sangti Valley, Arunachal Pradesh, India due to its scared status in Buddhism religion.

Buddhism has always been considered as preacher of co-existence and balance with nature (Madden 2008), especially in Ladakh's context (Norberg-Hodge 1991, Singh 2009). Scholars have attributed the Buddhism to be the factor responsible for tolerance of local communities of the Ladakh (Fox & Nurbu 1990, Jackson et al. 2003a, Bhatnagar et al. 2006) and Spiti valley (Mishra et al. 2003), or for the superstition due to which the Buddhist herders believe depredation results from deities they or the community angered (Jackson et al. 2003b).

Okello & Wishitemi (2006) noted that changing beliefs and opinions, through formal education system, of a community having a literacy rate of 40% could be challenging. Under such condition importance of working with the religious groups and community elders through informal education to incorporate conservation message and instill new beliefs have been

highlighted by Dickman (2008) and Okech (2011). The local community in the present study has a literacy rate of 53% (refer to Chapter 4) and hence instilling conservation message through formal education system would be wasteful.

The advantage that the conservationist and wildlife have here is the Buddhism religion followed by the local community. Messages given by the religious leaders are taken very seriously by local community so much so that one would notice very few Buddhist Ladakhi eating fish, as killing fish has been prohibited in Buddhism, in line with the prohibition to the monks regarding drinking of water containing living being, which might kill the insects in the water (McDermott 1989). This community specific religio-cultural value may help in designing community specific conflict mitigative strategies and conservation plan for an area.

Thus, besides providing protection to the wild animals and their habitat, the conservation plan for the region must also emphasize the need for conservation education program specific to the region, as the school textbooks are not effective enough in imparting education in local context. The formal protection provided to the wildlife habitat under National Parks and Wildlife Sanctuaries is an alien concept to the local community, since they have been living in close connection to the wildlife and yet boast of the well maintained and increasing populations of wildlife. These people need to be introduced to the concept and need of formal protection, with the help of religious leaders and village elders, in association with J&KWLPD.

6.5 SUMMARY

The role of formal education system to address conservation issues was analyzed through the content analysis of the government school textbooks of grade 5th to 8th. Presence of information on environmental issues; global examples; local specific examples; provision for interpretation in context of local socio-ecological linkages scored 1 each and the absence of these scored 0. Hence, the score ranged 0 to 8, for each parameter. The textbooks scored maximum for the presence of environment issues and global examples in all grades. While, the scores for local examples and linkages provided in the textbooks was only 12.5% of 8. Presence of Ladakh specific information was provided through single chapter in the geography textbook of grade VII, under the chapter 'Life in the Desert Region'. The textbooks available to the students of Ladakh do address environment issues, however these fail to address the local specificity of the environment and conservation issues, nor do they provide information on linkages to the local socio-ecological processes.

Leh and Kargil district's government school teachers' knowledge of and attitude towards wildlife conservation was assessed with the aid of self-administered questionnaire, having knowledge and attitude questions and statements. Teachers with fewer years of teaching experience were more knowledgeable than the higher experienced teachers [$F(1,275) = 4.565$, $p \leq 0.05$]. Teachers with a university degree were more knowledgeable than the teachers who had studied up to grade 12 [$F(1,275) = 18.019$, $p \leq 0.001$]. All the teachers with university degree were able to tell the correct list of wildlife

of Ladakh ($\chi^2 = 31.36$, $df = 1$, $p \leq 0.001$) and 89% of them knew the fact that Ladakh has protected areas ($\chi^2 = 27.12$, $df = 1$, $p \leq 0.001$) compared to teachers educated up to grade 12. One-way ANOVA revealed significantly higher knowledge for teachers who had studied in urban locality than those who attained education in rural locality [$F(2,274) = 8.725$, $p \leq 0.001$]. More than half of the teachers (62.5%) had favourable attitudes towards conservation. Attitudes were dependent on gender [$F(1,273) = 10.063$, $p \leq 0.05$] and provenance of teachers [$F(1,275) = 6.12$, $p \leq 0.05$], with female and native teachers having favorable attitudes towards conservation. Overall, the teachers of Ladakh were aware about the basics of local wildlife and had favorable attitudes towards them, closer scrutiny of the individual attitude statements revealed that the native teachers had unfavorable attitudes towards snow leopard. The unfavorable attitude can be accounted to the life experiences of the teachers, where they have grown up in a community, dependent on livestock rearing and any damage to the livestock causes significant economic loss. Despite this unfavorable attitude, the teachers agreed with the possibility of mutual co-existence. The religio-cultural upbringing of the teachers in Ladakh as Buddhist explains this attitude.

The interactions with religious teachers and scholars, as well as literature and personal observations revealed that plants and animals are used as symbol for religious teachings in form of storytelling. Buddhism teaches the philosophy of “ahimsa”, and prohibits killing of animal and thus is considered as preacher of co-existence. Scholars have attributed Buddhism to be the factor responsible for tolerance of local communities of the Ladakh

or for the superstition due to which the Buddhist herders believe depredation results from deities they or the community angered. The local community in the present study has a literacy rate of 53% and hence instilling conservation message through formal education system would be impractical and wasteful. However, since the local communities are strongly influenced by the Buddhism philosophy, the religious leaders could provide the message of conservation and may help in designing community specific conflict mitigative strategies and conservation plan for the area.



ANALYSIS OF CONSERVATION INSTRUMENTS AND RECOMMENDATIONS

7.1 INTRODUCTION

Measures to manage the negative impacts of human-wildlife interactions can be protective/mitigative (compensation and incentive schemes) (Hutton & Leader-Williams 2003, Distefano 2005, Madden 2008, McNeely & Mainka 2009, Eyebe et al. 2012) and preventive (through changing management practices or relocation, fencing) (Jones & Elliot 2006, Madden 2008, Eyebe et al. 2012). Both the mitigative and preventive measures aim at enhancing tolerance level of local community towards the wild carnivores and ungulates. Further, accordingly to Madden (2008) and McNeely & Mainka (2009) these measures could be effective only when they are regulative in nature and are supported by legal and policy framework. Policy statements could provide guidelines for effective implementation of these regulatory measures. Many instances are available where either absence of policy guidelines or failure of policy instruments to include market values and lopsided distribution of costs and benefits (market externalities) of conservation have contributed to intensification of negative aspects of human-wildlife interaction (Walpole 2001, Madden 2008).

Inadequate or absent land-use policies often have been cited as the cause of expansion of human populations to the wilderness areas and *vice-versa*, resulting in overlap of wildlife habitat with human habitations and

intensifying conflicts between humans and wildlife (Madden 2008). In Kenya, it was observed that land use change, in combination with changes in Kenya's ASAL (arid and semi-arid land) land use policy resulted in settlement of agricultural community in the Meru Conservation Area (MCA) which resulted in fragmentation of wildlife habitat, forced migration of pastoral communities to smaller areas and increased depredation of livestock and crop damage by wildlife (Otuoma 2004).

Human-wildlife interactions are usually reflected the most in economic terms of losses to the local communities due to livestock predation, crop and property damage and human injuries. Policy and legal instruments can play significant role in off-setting these costs with the benefits to the local community in form of incentives and payments aiming at empowering the most affected due to such conflicts (Ferraro & Simpson 2002, Madden 2008).

Since each area is unique in terms of biological, geographical and socio-cultural aspect, one model (policy measures) fits all, could not be expected to bring in the desired results. Mishra (2000) emphasized on the need for conservation policies to be sensitive to transient nature of local communities. If institutions are to respond to local subsistence need and sustainable natural resource management then monitoring mechanism and management arrangements need to be adapted to changing local context (Wakeel et al. 2005). Ignoring local communities' needs and aspirations while managing the PAs and lack of mechanisms to deal with human-wildlife conflicts had been attributed as main reason for limited success of conservation programs till the 1990's (Durbin & Ralambo 1994). Community

based conservation initiatives, such as Integrated Conservation and Development Program (ICDP), Joint Forest Management (JFM) have so far received combined results, where success is short term and possibly under limited situations (Salafsky et al. 1999, Campbell et al. 2003), questioning their long-term viability (Ferraro 2001). The reasons for success or failure are a mix of political, social, economic, cultural and equity factors, which are driven by the policies of the region or PA in question.

In view of the present scenario of human-wildlife interactions in Ladakh region and the context of causes for escalating human-wildlife conflict, this chapter reviews the existing policy instruments for the Ladakh region for their adequacy in dealing with conservation and mitigating conflict between development and conservation. The chapter then focuses on the existing situation in the Hemis National Park, *vis-à-vis* conservation challenges and role of policy instruments in tackling these.

7.2 METHODS

The analysis of conservation instruments initially reviews the status and condition of legislative framework and management practices *vis-a-vis* local people's dependence on natural resources and aspects of human-wildlife interactions in the HNP through extensive literature surveys and analysis of policy documents. Subsequently, it reviews the existing policy and legislative framework to examine whether the policy instruments recognize people's dependence on natural resources and ensures equitable access to resources; supports adaptive management to address the conflicts resulting

from human-wildlife interactions, by clarifying property rights, respecting customary rights, allowing compensation or incentive based mechanisms, promoting stakeholder participation, encouraging local institution with support from higher level. Major stakeholders and components in natural resource management were identified and the impacts of sectoral policies acts and rules on human-wildlife interactions, particularly the dependent local communities critically examined. The framework hence identifies the gaps in the policy and suggests future directions taking cognizance of current status and trends in human-wildlife interaction in the HNP.

7.3 RESULTS

7.3.1 Policy analysis

The Protected Areas (PAs) in the State of J&K are governed by the Jammu & Kashmir Wildlife (Protection) Act, 1978, which is an adapted version of Government of India's Wildlife (Protection) Act, 1972. These PAs are based on the IUCN's categories of PAs. The Hemis National Park was constituted in 1981, under the section 35 of the Jammu & Kashmir Wildlife (Protection) Act, 1978 to conserve the population of Snow leopard and its prey species (list provided in Chapter 2), which calls for extinguishing all the rights on the land and vesting the property right of the notified area with the government. The Act through its subsection 35 (6) makes removal, exploitation and destruction of wildlife or forest produce illegal, puts ban on utilization of the national park for commercial activity either by government or the local people and bans livestock entering into the park and using its resources for grazing and foraging (Table 7.1).

Contrary to the provision of the act, human habitations, livestock grazing as traditional use right (Anon. 2007) and tourism is present all along the Rumbak and Markha catchments of the National Park. However, the local communities residing in these catchment areas have been denied access to roads and other related amenities.

Since its conception, stipulations have been made to manage the HNP under zonation management system, with Rumbak and Markha catchments as buffer zones and rest of the areas as core zone, with least or no human activities (Fox et al. 1994, Anon. 2007). The Biosphere model for India has been developed on the lines of different zones having varying level of human activities, where certain human activities are allowed within a buffer zone, which is usually a wildlife sanctuary and the core zone is maintained as strict non-use habitat and is a National Park. The present management of the HNP is currently in lines with that of the Biosphere Reserve, especially with regard to human activities near the park boundaries and adjacent areas and declaration of HNP as Biosphere Reserve has been recommended since 1994 (Fox et al. 1994) and it is under consideration (Anon. 2007).

Table 7.1: Analysis of state level legislative instruments for human-wildlife interaction in Ladakh, India

Instruments	Recognition of people's dependence on natural resources	Recognition of human-wildlife conflict as a challenge	Equitable access to natural resources	Clarifying property rights	Respecting customary rights	Encouraging local institutions with strong support from higher levels	Promoting stakeholders' participation	Allows for compensation or livelihood based incentive schemes	Regulatory measures for natural resource protection	Provision for awareness creation
J&K State Forest Policy 2010	Recognizes local people's dependence on natural resources	Recognizes the need of managing the human-wildlife conflicts	Envisages active participation of every citizen in conservation, decision making and livelihood opportunities	Envisage clarifying property rights in collaboration between forest and revenue departments	Respects customary rights and intellectual property rights according to settlement report	Envisages participation of local institutions in implementation of policy visions	Emphasis on participation of the stakeholder groups	Allows for eco-tourism activities, but not necessary in direct context to conflict oriented incentive mechanisms	Envisages protection of the natural resources through legal measures	Provides for creating awareness among general public.
J & K Wildlife (Protection) Act, 1978 (2002 amendment)	Recognizes harmonizing the needs of the forest dependent communities with the wildlife protection	Recognizes the need to hunt down the wild animal which has become dangerous to human life or property	Does not promote equitable access to natural resources	Right over property and resource not clear	Envisages admitting of customary rights in cases where they are claimed and inquired	The act made no provision for respecting customary institutions	Envisages participation of local communities for creation of conservation reserves.	Makes provision for compensation for lost access to fuel, fodder and land	Provides for regulating the livestock movement and grazing and immunization of livestock	Is silent on awareness creation
J & K Forest Act, 1987	Recognizes people's dependence on natural resources and aims to meet this dependence from the village forests	Do not explicitly recognize human-wildlife conflict	Is silent on equitable access to natural resources	Tries to clarify property right	Is silent on customary rights	Though village communities are to manage the village forests, but the rules to be made by state government.	Is silent on stakeholder participation	Is silent on compensation or incentive mechanisms	Has made provision of penalty on activities leading to damage of natural resources	Is silent on awareness creation
J & K Kahcharai Act, 2011	Does not explicitly recognizes any other dependence on forest than the livestock grazing	Is silent on human-wildlife conflicts	Equitable access to resources is not applicable	Property rights clarification not applicable	Is silent on customary rights	Does not mention local institutions	It is silent on need of stakeholder participation and inter-sectoral integration	It is silent on need of measures to mitigate livelihood impacts due to human-wildlife conflict	Provides for regulatory measures to obtain revenue from levying of browsing and grazing dues	Is silent on awareness creation
LAHDC's Vision document	Recognizes local people's dependence on natural resources	Recognizes the need to manage the human-wildlife conflicts	Encourages geographically equitable development	Is silent on property rights	Is silent on customary rights	Encourages local institutions with support from higher levels	Promotes stakeholder participation	Encourages community-based tourism, as incentives to protect the wildlife habitat.	Is silent on regulatory measures pertaining to human-wildlife interactions	Provides for creating awareness on significance of Ladakh's biodiversity

Forest cover is virtually zero for the HNP and vegetation is restricted to shrub growth and *Populus*, *Salix* plantations in valley bottoms. The J&K State Forest Policy, 2010 is applicable to the forest and wild resources of the HNP. The policy provides scope for management of wildlife habitats even outside the PAs. It calls for minimizing disturbance to the wildlife habitats through minimization of human activities in the important habitat of wildlife. The policy aims at improving management plan of the PAs of the state of J&K, for better conservation. It recognizes human-wildlife conflict as a priority issue and calls for inter-department co-operation and co-management with the local community for addressing the conflicts. Education and awareness also scores high on the policy's objectives. Eco-tourism is recognized as a means for developing eco-sustainable livelihoods to the local communities, and calls for providing training to them to participate in eco-tourism activities. Role and importance of participatory forest management and extension are also acknowledged by the forest policy (Table 7.1). The J&K Kahcharai Act, 2011, provides scope for imposing grazing fee/tax/duty on livestock grazing in the non-village land and also makes provision of the local community member e.g. patwari to act as "Kahcharai Officer", allowing him to collect the grazing revenue as per the rules set by the Kahcharai Act 2011 (Table 7.1).

7.3.2 Analysis of the LAHDC's 2025 vision document

The LAHDC's 2025 vision document provides for inter-department co-operation, specifically the co-operation and coordination between Livestock Husbandry and J&K Wildlife Protection Department. The eleventh chapter of the vision document outlines the strategies envisaged to be adopted for

conserving natural resources and protecting them, including from the human-wildlife conflicts. The strategies justly call for local community participation in conservation and tourism activities, minimizing human-wildlife conflicts, and in creating awareness. While another chapter envisages reducing pressure in winter pastures through revival of traditional migration pattern, discouraging competitive grazing, levying of green tax on tourists, promoting community based tourism through capacity building and infrastructure development (Table 7.1). The vision document also acknowledges the lack of local reference/context in the present day education system followed in Ladakh and thus plans to make education holistic and in context with Ladakh's cultural, geographical and natural set-up (LAHDC 2005).

7.4 DISCUSSION

7.4.1 Policy implications

The practice of having a common policy throughout the region, without consideration of local factors and interaction of these factors at local level, has hampered the basic aim of the policy itself. The wildlife and forest acts/policies applicable in Ladakh region of the J&K state are similar to those applicable to whole State, adapted from central Government policies for the rest of the country.

The J&K's forest policy's objectives to conserve the biodiversity and natural habitat along with poverty alleviation of the forest dependent communities provide scope for the participatory management of the resources in the Rumbak and Markha catchments. The policy also provides opportunity

for containing human-wildlife conflict through restriction of human activities inside the core habitat areas; inter-sectoral co-operation and partnership and participation of local institutions and awareness creation. The J&K Forest Policy envisages reconciling of land records of Revenue Department with that of Forest Department and seeks to resolve inter-sectoral conflicts by mutual harmony with other department's policy objectives. Though there is no dearth of government's initiative for participatory approaches, the objective of containing human-wildlife conflicts has not been dealt holistically. What is missing from the approaches is the ability to address and capacity to deal with the market and information failures. Appropriate strategy involving policy instruments and mixes, along with integration of inter-sectoral legislative measures is the way forward to mitigate the negative interactions of humans with the wildlife.

In order to contain this HWC situation, effective policy instruments that would work in coherence with other market and institutional instruments and with inter-department alliances are needed. If institutions are to respond to local subsistence need and sustainable natural resource management then monitoring mechanism and management arrangements need to be adapted to changing local context (Saberwal 1996, Mishra 2000, Gulati & Gupta 2003, Wakeel et al. 2005).

7.4.2 Implication of LAHDC's 2025 vision document on human-wildlife interactions

Developmental policies have implications for the communities' socio-economic structure, their well-being and changes in their traditional systems, which have been acknowledged by the LAHDC's vision document (LAHDC 2005). Though much of the vision statement are in favour of conservation of natural resources of Ladakh and revival of Ladakhi sustainable society, but in absence of clear policy directions from other departments, especially in areas where conservation and development may not go hand-in-hand, the vision statement might adrift from its vision to recreate a sustainable model hill society. To improve agriculture productivity, the vision document calls for bringing in more land under cultivation. The need to provide food security to the Ladakhi people from own limited resources, through intensification of agriculture, and bringing more area under agriculture could have serious implication for the human-wildlife interactions, where non-consideration of conservation status, wildlife habitat and the need of corridors for wildlife can lead to higher incidences of wildlife related monetary losses and reduced tolerance of people towards wildlife as has been noted in Mara Conservation Area (Otuoma 2004). Absence of clear Land-Use Policy for the region could make conservation even more contentious, where people residing in and adjacent to protected area would want to get the same agricultural and development benefits as the ones settled away from the PAs.

Tourism is one of the major sources of employment for Ladakhi people (LAHDC 2005), the vision document calls for decentralizing tourism

infrastructure to villages and thus also envisages infrastructure development, exploring new trek routes, removing permits. Entry permits into a PAs of Ladakh provides a way to keep tab on the number of tourists and associated people entering the PAs, removing the permits might open the area for tourists beyond the carrying capacity of the ecosystem, as well as beyond the capacity of the local infrastructure.

The vision document aims at providing benefits of tourism to the Ladakhi society. The tourism management in Ladakh could gain some insights from example of tourism management on the basis of pricing management. Bhutan provides a classic example of “high value, low impact” tourism management, whereby making visit to the country affordable to only few people (Gurung & Seeland 2008), while the Nepal, in absence of any pricing mechanism attracts backpackers to its PAs (Brown et al. 2007) and Kenya, Botswana, Rwanda and Ecuador limits the number of tourists entering the PAs on the basis of pricing policies specifically for PAs (Gossling 1999, Mmopelwa et al. 2007).

Ives & Messerli (1989) and Fox et al. (1994) noted that ubiquitous presence of military, rapid growth of civil administrative structures and tourism has resulted in replacement of subsistence economy with the heavily monetized economy in Ladakh. Though these changes are more pronounced in the towns and large villages, located at the road heads, however they do have implications for the remote villages, affecting the aspirations of the communities. It has been argued that concomitant changes in people–

landscape interaction (changes in livestock holding and grazing pattern, resource utilization – fuel and fodder collection) have fundamentally resulted from the social and economic changes, directly affecting natural resource conservation.

7.5 WAYS TO MITIGATE THE NEGATIVE EFFECTS OF HUMAN-WILDLIFE INTERACTIONS

Compensation is considered the best way to provide the local communities the monetary value of loss that they incur due to their co-existence with the wild animals. However, examples across the globe show that compensation schemes generally have not been a practical approach to contain human-wildlife conflicts (Sekhar 1998, Nyhus et al. 2005, Lamarque et al. 2008, Ogra & Badola 2008). Compensation as mitigative stand is a short-term strategy, since it does not look into the root cause of conflict (Hockings & Humle 2009). The compensation mechanism does little to increase tolerance of people towards wildlife caused losses (Bowen-Jones 2012) and governments may become trapped into compensation schemes (Wagner et al. 1997) and in case of crop-loss, compensation acts as agricultural subsidy, further inducing habitat loss (Rondeau & Bulte 2007). Instead focus could be on non-consumptive resource utilization aiming at livelihood diversification and financial incentives for conservation such as involvement in tourism activities, production of value added products (livestock based). These could provide direct payments to the local communities, which are considered to be better than the indirect development intervention and could improve welfare of the local communities (Ferraro & Simpson 2002, Sekhar 2003). Framing rules

to benefit local communities, living inside the PAs, from tourism has been considered as a payment option across many countries e.g. Mozambique. But it should be noted that the local income from tourism is also affected by the kind of tourism in the area, as observed by Drumm (1991) and Wunder (2000) for Ecuador; by Groom et al. (1991) for Peru. They found that local income share was higher in backpacker expenditure, while the share in up-market tourism expenditure was minimal, since most of the services are provided by the tour operators from the cities and hence they observed “primitive tourism (backpackers) has a higher local multiplier and backward linkage effect than the up-market version of tourism”.

Land-use plans, based on resource availability, at regional as well as village level must make account of the needs of local community and wildlife. It has been highlighted that land-use policy play significant role in aggravating HWC, where the lack of land use policy or inadequacy, allows either expansion of human activities around the wildlife areas or antagonistic human activities to take place around the PAs. For example, in Bwindi National Park, Uganda (Madden 2008) absence of land use policy resulted in expansion of human settlements and farms in areas adjacent to the PA which attracted gorillas and intensified HWC. In Kenya changed land use policy resulted in establishment of settlements along the migratory pathways of the wildlife and have increased the HWC in the region (Tarayia 2004).

Land-use planning and management are lengthy procedures and require inter-departmental understanding. Other immediate preventive

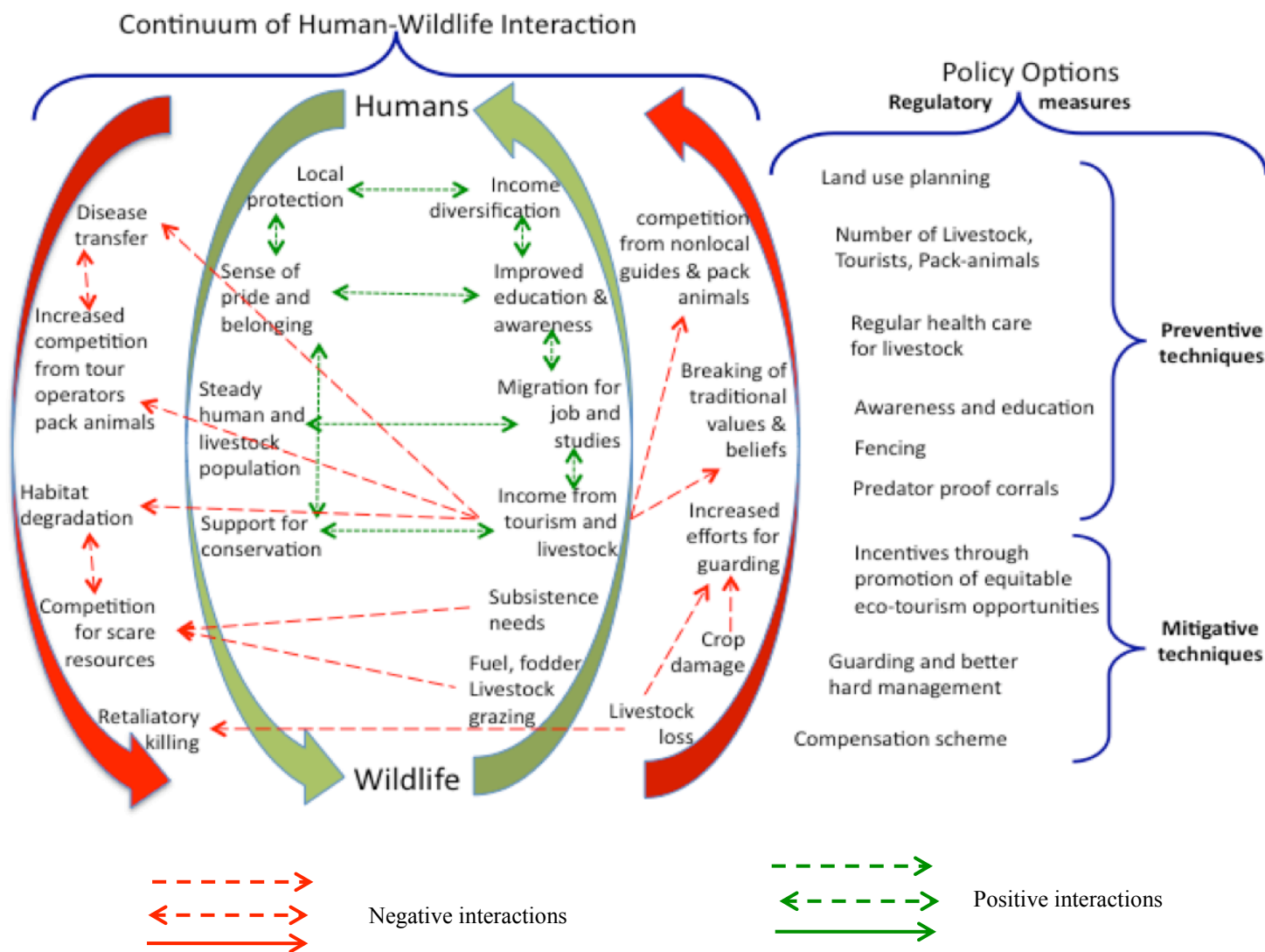
measures that can be readily available to resolve negative impacts human-wildlife interactions are: predator proof corrals; better herding and guarding techniques; veterinary care for the sick and injured livestock; avoiding areas where the presence of predator is known; direct payments to local communities through eco-tourism; sale of value-added products; awareness of local community through conservation education and religious teachings.

McNeely & Mainka (2009) outlines the steps necessary for reducing negative impacts of co-existence through first reducing the conflict with the aid of short-term biological approaches, followed by change in human behavior through increased tolerance and finally implementing profit-sharing and land-use planning to prevent future conflicts from occurring. Hence, land-use planning, community empowerment and economic incentives are key to mutual co-existence.

Figure 7.1 provides an outline of human–wildlife interaction in the study area and policy options applicable for the study area. The livestock loss due to wild carnivore often resulted in retaliatory killings of the predator species few years back (Mallon 1991) and evidences of it can be seen in form of stone-pit wolf trap that are visible along the trek trails of Markha valley (Plate 9.b). Crop loss due to wild ungulates has resulted in residents to choose between the best agriculture farm within the reach of their houses or temporary shifting of the house for the duration of agricultural season. The compensation scheme was started in HNP, similar to other PAs in India, but due to its limited success and challenges associated with it, the scheme has

been stopped and instead focus is on mitigative options such as guarding and better herd management, involvement of local communities in direct income generation activities, such as tourism; and preventive measures such as predator-proof corrals. Tourism in the study area is providing incentives for livestock loss in some parts of the study area as is evident from this study. The direct payments received from tourism is being used for improving social capital of the region, as large number of children from the study area were observed to temporary migrate out of the study area for job or studies. Higher returns from tourism is found to have increased tolerance level of the local communities as they take pride in living in the wildlife habitat and being part of the conservation community. A small area in Rumbak catchment is being protected by the active support from the local community. This area is only few of the remaining pockets of HNP, where three species of wild ungulates can be seen (Namgail et al. 2004). The income from tourism has also diversified the income source of the residents. However, higher tourist influx in the limited period of 4-5 months is found to impact the habitat of the region, through trampling and garbage disposal (Geneletti & Dawa 2009). The unregulated tourism and tour operators can pose threat to wild ungulates, as the increased number of pack animals from outside the HNP would compete with the livestock already inside the HNP as well as the wild ungulates. Also, the unvaccinated or diseased pack animals can cause spread of disease among the ungulates. The unregulated tourism can also threat the local economy based on tourism due to increased competition with the guides and hired pack-animals from outside the HNP, thus decreasing the share of the local income in the tourism.

Figure 7.1: Human-wildlife interactions in the study area and relevant policy options (regulatory measures)



Tourism infrastructure provided by the local community in the study area is often found to be competing with the services provided by the up-market trek organizers, and little share of locals in the income hence obtained. On the basis of these observations following recommendations are made for the continued co-existence and survival of humans with wildlife.

7.6 RECOMMENDATIONS

7.6.1 Mitigative options

Compensation scheme has not worked for the HNP and hence the scheme was closed, but still some people can be seen in the Wildlife warden's office requesting for the compensation. Lack of authentic information of livestock loss from remote villages is a challenge for the WLPD, whereas the amount of compensation received is never equal to the actual loss hence the local people remain dissatisfied. However, livestock and crop insurance scheme, as in Spiti, Himachal Pradesh (Mishra et al. 2003) can be started in the area, with community involvement.

Incentive program such as promotion of sale of handicrafts, and payment made to local communities towards the pastoral area foregone for conservation, as already underway in Rumbak valley should be recognized and replicated with consent and involvement of local communities in other village settlements all along the trek routes of the HNP.

Traditional grazing rules should be strictly followed by all the shepherds of the local community. Restricted grazing by migratory livestock in critical

wildlife habitats, most importantly the PAs, and demarcation of grazing and non-grazing areas or core and buffer areas in PAs needs to be carried out, in consultation with the local community. Grazing areas should be designated for the pack-animals accompanying the trek groups, so that they do not graze in wildlife habitats. Regulatory measures, e.g. fine and suspension/cancellation of permits should be imposed on the tour-operators who do not follow the norms set for grazing. Honorary positions should be created within the village hamlets for appointment of the person who could monitor the movement of the pack-animals and be authorized to impose spot fines.

The Shang village cluster, located near the city of Leh, have easy access to market facility, and rarely are involved in tourism activities. But they do incur losses due to livestock predation. The losses incurred to them appeared to be significant proportion of their income since most of them were primarily dependent on agriculture. Due to main settlement's location off the trek-route, nearness to the city and trek-operators' own resources had been cited as the reason by the residents of these settlements for not receiving direct benefits of tourism. In case of no direct benefit of eco-tourism from the HNP in lieu of the losses due to livestock predation, the residents could easily get lured to the idea of expanding their agricultural fields. This could further intensify the losses to the residents of this particular settlement, where crop loss, at present is reported by every household and wild ungulate (*Pseudois nayaur*) can be easily sighted near the agriculture fields. Ways to provide incentives to these villagers could include popularizing the off-trek routes as cultural and wilderness area, for an experience of Ladakhi lifestyle. Local

products made by the residents could also be promoted for sale to the tourist groups for enhancing incomes.

General income activities were most diversified for the residents of Chilling and Shang village clusters, whereas the residents of Markha and Rumbak derive income from tourism options only. This dependence on seasonal tourism makes them susceptible to changes in tourism and PA policy. With limited options, the present situation of deriving maximum income from tourism in the Markha and Rumbak clusters is the best option to meet the sustainability model, where non-consumptive resource use contributes significantly to the livelihoods.

7.6.2 Preventive options

The predator proof corrals that were being constructed throughout the human settlements across the Hemis landscape at the time of the study need to be maintained on periodic basis. However, the kind of material used for construction of the predator proof corrals has been kept in mind. As, one of the respondents told that the barbed wire used in corrals was not good for the quality of Pashmina, as the goats would often get entangled in the wire. Hence, chain link wire is a better option if the corrals have to provide shelter to the Pashmina goats, where quality of hair won't be compromised for saving the lives of the reared bovines.

In case of predation of large bodied livestock, attended herding is not possible all the time, since these animals require large area to feed upon and

lack of human resource poses challenge in herding. Lack of manpower, due to changing aspirations and values within the younger generation also contributed to causes of livestock mortality. Shepherd dogs are known to herd the livestock and also to warn of the presence of the predator species, but in absence of any training these dogs often are left free and often become feral. Many instances are known where these dogs become threat to the livestock (present study) as well as the wild ungulate (Namgail et al. 2007b). Due to these reasons, guarding herds and shepherd dogs were not found to be useful by half of the households. Keeping the large bodied livestock within sight (at a distance from where watch can be kept) could be one of the alternatives. Similarly, guarding of crops was not successful in cases where agricultural fields were scattered and small. However, timing of the guarding requirement clashes with the timings of the household work. Allocation of households to take turn to guard the fields could be a better way of sharing and utilizing the social capital.

Spreading awareness among the residents of HNP on the range of benefits that they could receive in lieu of co-existence with the wild animals, through community awareness and sensitization program, religious teachings and bringing up local specificity in the text-books of school children could result in sense of pride and belonging among the residents of HNP. Also, there is need to spread awareness among general public, tour-operators, tourists and the government officials, so as to bring all of them to similar platform of understanding the need to provide incentives to the local community of the HNP or any other PAs of the region.

Regular health care check-up of the livestock and proper veterinary facilities could minimize the risk of disease transfer and also could reduce livestock mortality of weak and injured livestock. Additionally, routine check-up of the all the pack-animals entering the HNP could be made mandatory, to reduce risk of disease transmission in the livestock of HNP's residents.

The shift in economic conditions and occupational patterns in the study area can be seen as a positive sign for successful conservation of wildlife, but tourism – the main factor for changing economic set-up should not be left unguarded as the region is one of the most vulnerable ecosystems and is a habitat to the threatened and endangered species. Regulated tourism will help in maintaining a balance between the booming economy of the residents, and the wildlife habitat. Keeping a tab on number of tourists, pack-animals, support staff entering the trek-routes of HNP through various entry points, in accordance with the carrying capacity of the ecosystem and the capacity of the local community would ensure resilience of the system. Ensuring higher or substantial local share in tourism income through imposition of rules, such as hiring of guides and pack-animals from the local community of the HNP, encouraging home-stays instead of tents could further compensate the losses due to predators and enhance the tolerance of local community towards such losses. Providing equal opportunities to the local communities all along the HNP, would ensure continued support for conservation. The aim should be to maximize benefits but not at the cost of unsustainable practices.

There is an immediate need of land use planning for the areas surrounding the HNP, since need to improve the agricultural outputs in the

villages totally dependent on agriculture could drive them to intensify the agricultural practices and take up measures, such as fencing, which could act as barrier for easy movement of the wild ungulate across the habitat. Land use planning for the village clusters is needed and where present it should be documented, so as to maintain the areas specific for grazing, trek trails, wildlife habitat. However, while marking the trek trails for tourists, care should be taken to provide equal opportunity to all the residents within the HNP.

Involvement of local communities in formulation of mitigative and preventive measures is must for success of these measures, as has been evident from vast literature and the experience in the region (Jackson et al. 2003, Madden 2004). The process of co-management or community-based conservation such as ecodevelopment provides scope for such measures. The local communities should be part of the consultations, planning and implementation as well as of feedback to achieve aim of conservation and development. Inter-department co-operation and policy coherence is needed for successfully managing the co-existence model of HNP and showcase the best management practice to the world. The Forest Policy of J&K State government, the LAHDC's vision document provides scope for such measures and should be utilized for an immediate action toward management for co-existence.



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Source: 2001 Census – www.censusindiamaps.net



Appendix-I



Teachers' Knowledge of and Attitude Toward Wildlife and Conservation

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Teachers' Knowledge of and Attitude Toward Wildlife and Conservation

A Case Study From Ladakh, India

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Environmental education (EE) has recently been included in school curricula in India to improve understanding of ecosystems, their functions, and the effect of human actions on them. The need for EE is more pronounced in

Ladakh, in the Indian Trans-Himalaya, where recent development activities pose challenges for the fragile mountain ecosystem and for traditional livelihoods. Inclusion of EE in school curricula by the Jammu & Kashmir State Education Board and a conservation education program organized jointly by various government and nongovernmental agencies across Ladakh are some of the significant steps taken. As part of the Wildlife Institute of India's collaborative

conservation education program, a questionnaire survey was conducted to explore Ladakh school teachers' knowledge of and attitude toward wildlife and conservation. In all, 277 government school teachers took part in the study. Results of the study highlight that teachers in Ladakh are aware of local biodiversity and have favorable attitudes toward conservation. However, responses to specific statements on snow leopards (*Panthera uncia*) were found to be unfavorable. Despite a high percentage of respondents agreeing that conservation of snow leopards was important, they also were considered as a threat to the local economy. The study identifies the need for intensive preservice and in-service environmental education programs to spread conservation awareness.

Keywords: Knowledge; attitude; teachers; snow leopard; environmental education; conservation; Ladakh.

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Introduction

Environmental education (EE) is an important tool for improving people's understanding and for motivating local communities to cooperate and take initiatives for conservation and sustainable resource use (Pritchard 1968; Cerovsky 1969). The basic aim of an EE program is to assist people in developing awareness, knowledge, and appreciation of natural resources so they can make informed decisions, driving responsible behavior and constructive action (Leopold 1949; UNESCO 1980; Roth 1992). The importance of EE is highlighted by studies on relationships among knowledge, attitude, and behavior by emphasizing that an individual must have relevant knowledge to hold a positive environmental attitude, which, in turn, is a moderate predictor of behavior (Zimmerman 1996; Bradley et al 1999; Kaiser et al 1999; Pe'er et al 2007; Tuncer et al 2009; Esa 2010).

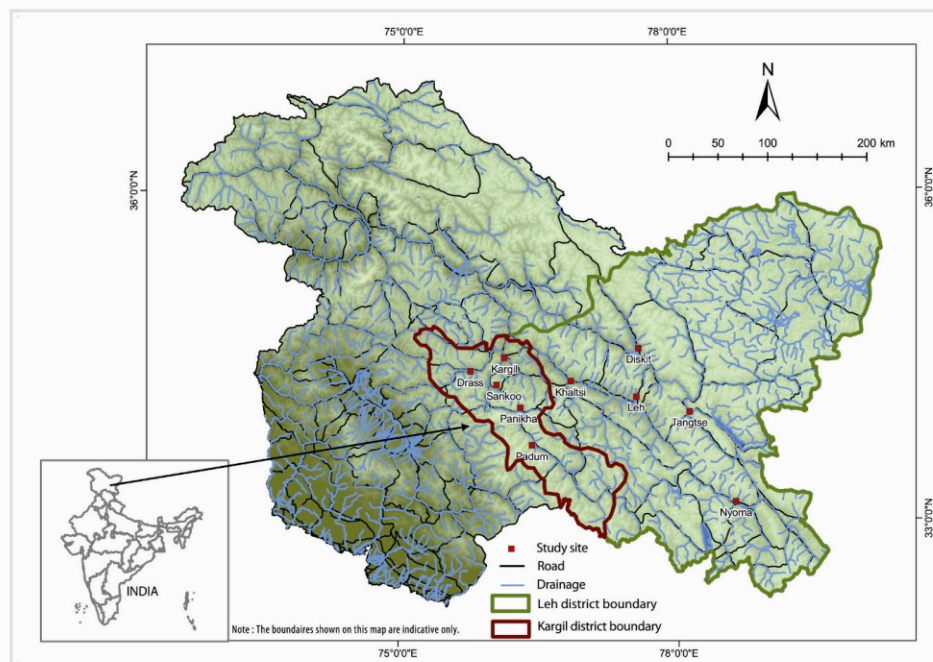
In recognizing the importance of and need for EE, India's National Policy on Education (1986), supported in 1991 by the Supreme Court of India's direction, made EE compulsory at all levels of education. However, it was realized that the desired result of curricula revision will not be attained unless simultaneous changes are made in the teacher education curricula to prepare teachers for EE. Hence, in 2005, the

National Council for Teacher Education made EE a compulsory course in teachers' training (NCTE 2005).

As in other mountain societies, until the 1860s, education in Ladakhi society largely took place in the villages, in the fields, and by the family hearth (Norberg-Hodge 1991; Mingle 2003). Efforts to improve both the literacy rate and education led to an increase in the number of schools, from 72 in 1958 (Nair 1958) to 884 at present. Rizvi (1986) and Norberg-Hodge (1991) observed that modern schooling prevented children from viewing the context in which they live, which led to diminution of traditional values, skills, and sustainable lifestyles. The need for EE is more pronounced in Ladakh since development activities, concentrated over the past decade, have increased the vulnerability of its fragile mountain ecosystem and of the traditional livelihoods of the local communities. Responding to these concerns, the Jammu & Kashmir State Education Board along with the Centre for Environment Education worked toward inclusion of EE in school textbooks and in teachers' training curricula (Ravindranath 2007).

Simultaneously during 2005 and 2006, the Wildlife Institute of India, the International Snow Leopard Trust, the Centre for Environment Education, and the Snow Leopard Conservancy designed a conservation education program for Ladakh, which comprised dissemination

FIGURE 1. Map showing location of the study sites. (Map by Wildlife Institute of India)



material and workshops for government school teachers. Ecological information used for this program was obtained through the project “Strengthening field conservation through ecological studies, capacity building, and conservation awareness in the Ladakh Trans-Himalaya,” which was a collaborative initiative of the Wildlife Institute of India, the International Snow Leopard Trust, Centre for Environment Education, and the Snow Leopard Conservancy. As part of the conservation education program, a study was undertaken to assess Ladakh teachers’ knowledge of and attitude toward wildlife conservation, because little is known about this. Hence, the present study answers the following questions: (a) What is the ecological knowledge and attitude of the teachers? (b) What factors determine their knowledge and attitude? (c) Is there any relation between knowledge and attitude?

Study area

The study was conducted in Ladakh, located between 32°N and 36°N latitude and 75°E and 80°E longitude, in

the State of Jammu & Kashmir, India (Figure 1). Ladakh is known for its fragile mountain ecosystem and unique geographical and geological features, with a rare floral and faunal assemblage (Namgail et al 2012). The region is a stronghold of Trans-Himalaya endangered carnivores and ungulates such as the snow leopard (*Panthera uncia*), Ladakh urial (*Ovis vignei vignei*), and Tibetan argali (*Ovis ammon hodgsoni*). Besides, 225 bird species have been recorded in Ladakh, and its high-altitude wetlands provide breeding grounds for the bar-headed goose (*Anser indicus*) and the globally endangered black-necked crane (*Grus nigricollis*) in India (Hussain et al 2008).

Administratively, Ladakh is divided into 2 districts, Leh and Kargil, which are further subdivided into 6 and 7 administrative units, respectively, known as blocks. Each block has a headquarter located in a town or city. At present, 3356 teachers teach in 884 government schools of Ladakh. Most of the government teachers are natives of Ladakh and were brought up in a rural setting, with the exception of the young generation of teachers, who were educated outside Ladakh. Livestock rearing and

TABLE 1 Teachers' responses to the knowledge statements ($n = 277$).

Statements	Yes (%)
The snow leopard is an endangered species.	98.3
Conservation education provides knowledge on the wise use of resources.	92.5
The correct names of wild animals not found in Ladakh were given by:	83.2
Each and every wild animal forms a part of the food web.	76.5
Hemis is the name of a famous national park and monastery.	61.7
The new textbooks provide good examples of the local environment.	56.9
Old/present textbooks provide enough information on the environment and its conservation.	37.3
Ladakh's biodiversity is truly unique.	85.0
The snow leopard lives in and around rocky mountains.	95.0
The correct list of Ladakh's wildlife was identified by:	62.0
Ladakh has national parks and wildlife sanctuaries to protect wildlife.	70.0
Old/present textbooks provide enough information on Ladakh's wildlife.	36.0

subsistence agriculture, the main traditional livelihood options, are still practiced by the families of the teachers. Both livelihood options are historically known to be threatened by the wild carnivores and ungulates of the region (Bhatnagar et al 1999).

Methods

As part of the conservation education program for Ladakh, conservation education workshops were organized into 10 administrative block headquarters, across Leh and Kargil districts (Figure 1; Table S1, *Supplemental data*, <http://dx.doi.org/10.1659/MRD-JOURNAL-D-11-00040.S1>), during 2005 and 2006. The government school teachers teaching science and related subjects were nominated by the school administration to attend these workshops. To assess the knowledge and attitude of teachers in Ladakh, a questionnaire schedule was administered to the participating teachers before the start of the workshops. The teachers were told to return the duly completed questionnaire before commencing the training session. The purpose of this voluntary exercise was explained to

TABLE 2 Teachers' responses to the attitude statements ($n = 277$).

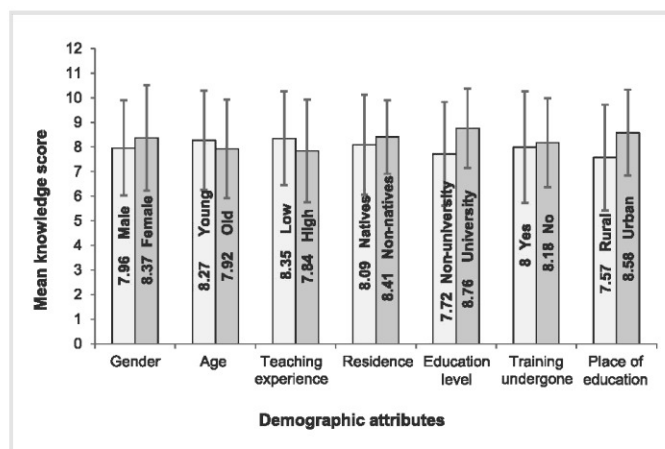
Statements	Yes (%)
It is important to teach children about conservation.	98.5
Natural resources form an important part of human wellbeing.	98.3
It is good that environmental education has become an integral part of the school curriculum.	97.4
For human survival, the wise use of natural resources is important.	96.7
Children should be taught about the local as well as the global environment.	94.8
Wildlife education should be made an integral part of the school curriculum.	93.7
Wildlife is beneficial for people.	85.7
Conservation of the snow leopard is necessary for human survival.	84.2
The snow leopard is a serious threat to people living in remote places.	74.3
Snow leopards and humans cannot live together harmoniously.	55.7
For a teacher, there is no use in learning about conservation education.	35.3
Children should be taught about the local environment only.	23.9

them. Of 326 workshop participants, 277 voluntarily took part in this study.

The questionnaire schedule was divided into 3 sections. The first section obtained demographic data, the second section explored the teachers' knowledge through a set of 12 statements (Table 1), whereas the third section examined their attitude through another set of 12 statements (Table 2). All the statements had "yes" and "no" responses. Correct answers to each knowledge statement were given a score of 1. Hence, the overall knowledge score for each respondent was obtained by adding the correct answers to the 12 knowledge statements. For attitude statements, a favorable response (yes) was given a score of 2, whereas an unfavorable response (no) was given a score of 1; by adding coded responses for each attitude statement, we obtained the overall attitude score for each teacher. Higher attitude scores represented favorable attitudes, whereas lower scores indicated unfavorable attitudes.

The teachers were classified according to gender (male/female), age (young [<34 years]/old [≥ 34 years]), teaching experience (low [<12.5 years]/high [≥ 12.5 years]),

FIGURE 2 Teachers' demographic attributes and mean knowledge score (error bar denotes the standard deviation of the mean).



preservice training undergone (yes/no), education (up to grade 12/university degree), place of education (rural/urban), and provenance (natives/non-natives), to see if these factors influenced knowledge and attitude.

The results were analyzed by using descriptive, one way analysis of variance (ANOVA), correlation and χ^2 statistics, via SPSS 16.0.

Results

Demographic profile of respondents

Demographic attributes of 277 respondent teachers are summarized in Table S1 (*Supplemental data*, <http://dx.doi.org/10.1659/MRD-JOURNAL-D-11-00040.S1>). Overall, female representation was 34.5%; however, when gender participation was examined by location, it was found that female representation was higher in Tangtse, Diskit, Leh, and Khaltsi than in other places. The mean age of teachers was 34 ± 7.76 years, and they had an average of 12.5 ± 9.11 years of teaching experience. Participants from Leh, Khaltsi, Drass, and Panikhar were more experienced than those from other places. Most of the teachers (63.8%) had studied up to grade 12, whereas 36.2% had a university degree. Leh had the highest share of teachers who had undergone teachers' training (92.9%). Overall, only 41.5% had undergone such training. About 57% of participants taught science as an individual subject or in combination with other subjects. The highest percentage of non-native participant teachers was noted for Tangtse (52.6%).

Ecological knowledge of the teachers

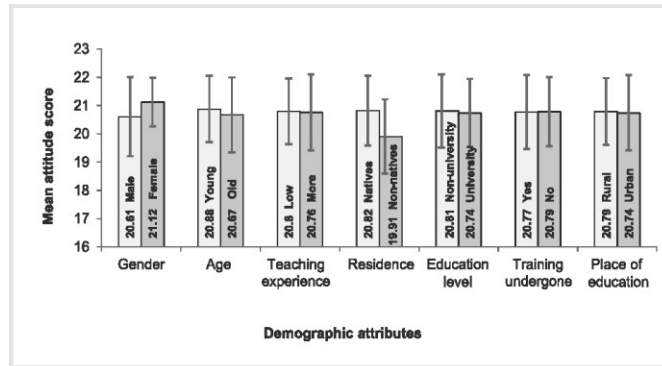
Responses to statements that aimed to establish the knowledge of the teachers are summarized in Table 1. Knowledge scores ranged from 3 to 12, with a mean of 8.11 ± 2.02 . More than half of the respondents (61.3%) scored 8 or higher. Knowledge scores were dependent on the teachers' teaching experience, education, and place of education. Those who had fewer years of teaching experience (8.35 ± 1.91 years) had higher knowledge scores than more experienced teachers (7.84 ± 2.09 years) ($F[1,275] = 4.565$; $P = 0.034$). Teachers who had a university degree (8.76 ± 1.62) scored higher in knowledge than teachers who had studied up to grade 12 (7.72 ± 2.11) ($F[1,275] = 18.019$; $P = 0.000$) (Figure 2). Compared with teachers educated up to grade 12, higher knowledge scores were observed for teachers with a university degree because all of them (100%) were able to tell the correct list of wildlife of Ladakh ($\chi^2 = 31.36$; $P = 0.000$; $df = 1$), and 89% of them knew the fact that Ladakh has protected areas ($\chi^2 = 27.12$; $P = 0.000$; $df = 1$).

Place of education played an important role in determining the knowledge of the teachers. One-way ANOVA revealed significantly higher knowledge scores for teachers who had studied in an urban locality (8.58 ± 1.75) ($F[2,274] = 8.725$; $P = 0.000$) than for those who had attained education in a rural locality (7.57 ± 2.15) (Figure 2).

Attitudinal response of the teachers

In general, a large percentage of teachers had favorable attitudes (Table 2). Teachers' overall attitude scores ranged from 17 to 24, with a mean of 20.78 ± 1.25 . More

FIGURE 3 Teachers' demographic attributes and mean attitude score (error bar denotes the standard deviation of the mean).



than half of the teachers (62.5%) scored above 20, which indicated favorable attitudes. Female teachers (21.12 ± 0.86) held more favorable attitudes compared with male teachers (20.61 ± 1.40) ($F[1,273] = 10.063$; $P = 0.002$). Similarly, attitude scores were higher for native teachers (20.82 ± 1.24) than for non-native teachers (19.91 ± 1.31) ($F[1,275] = 6.12$; $P = 0.014$) (Figure 3).

Despite the high percentage of teachers agreeing about the benefits of wildlife (85.7%), snow leopards were considered a serious threat to people living in remote places by three fourths of the teachers (74.3%), and more than half of the teachers (55.7%) felt that snow leopards and humans cannot live together harmoniously (Table 2). When further exploring these statements against demographic attributes, it was found that more natives (76%) perceived snow leopards as a threat than non-natives (42%) ($\chi^2 = 6.95$; $P = 0.008$; $df = 1$).

Relation between knowledge and attitude

A significant positive correlation was observed between teachers' knowledge and attitude scores. This correlation, though weak ($r = 0.242$; $P = 0.000$), contributes to the literature on the positive relation between knowledge and attitude.

Discussion

For teaching conservation to schoolchildren, the prerequisite is that teachers should be knowledgeable in terms of ecology and biodiversity conservation, and should have affirmative attitudes toward wildlife conservation. This study suggests that teachers in Ladakh are knowledgeable about the basics of local wildlife and have favorable attitudes toward wildlife, except when it threatens their economy, in this case, the snow leopard,

which causes significant economic losses at the local level (Bhatnagar et al 1999).

Until recently, Ladakh had little access to higher education; the number of schools was limited to 72 in 1958 (Nair 1958). Hence, older teachers tended not to have a university degree, which explains the negative correlation. Although the number of primary and high schools has increased, there is still only one degree college in Leh and young people go outside Ladakh for university education, which explains the fact that young teachers are more educated and were educated in urban settings, mostly outside Ladakh.

The study found that teachers who had university degrees were more knowledgeable. These findings are in conformity with studies by other scholars (Fiallo and Jacobson 1995; Pyrovetsi and Daoutopoulos 1997; Gillingham and Lee 1999; Badola et al 2012) who concluded that education is an important factor that influences knowledge. Higher knowledge scores were observed for teachers educated in an urban locality. Respondents who were educated in an urban setting also definitely had a university degree. Hence, we concluded that studying in an urban setting provides ample access to the various sources of information as well as opportunities for higher education, which leads to holistic knowledge and better understanding.

The favorable environmental attitudes shown by female teachers in the present study support findings of Zelezny et al (2000), Alp et al (2006), and Tuncer et al (2009). Research results have shown that females express more concern about the environment than males, irrespective of cultural and educational status (Worsley and Skrzypiec 1998; Eagles and Demare 1999; Tikka et al 2000; Loughland et al 2003). Bord and O'Connor (1997) explain this as being due to differences in perceived

vulnerability to environmental risks. Traditionally, women have been closer to nature while performing day-to-day activities, when even providing meals for the family is linked to nature, and women also perceive changes in the environment, which affects their capacity to provide for the family.

Tanner (1980) and Peterson (1982) suggest that informal education and life experiences with role models, such as parents and teachers, are crucial factors in developing the environmental sensitivity of an individual, which indicates that age and education did not influence the attitude of the teachers. Newhouse (1990) argues that favorable attitudes toward the environment are perhaps developed on the basis of life experiences rather than any educational program, which holds true for the present study, because native teachers of Ladakh were found to have higher attitude scores than non-natives. The strong background of traditional ecological knowledge reflected in the folk songs and the tradition of hunting and gathering resources for self-sustenance (Norberg-Hodge 1991; Koshal 2001) explains the overall favorable attitude of native teachers.

However, closer scrutiny of the individual attitude statements revealed that the native teachers had unfavorable attitudes toward snow leopards. We attribute this to the life experiences of these teachers, who grew up in a community dependent on livestock rearing, where any damage to livestock caused considerable economic losses (Bhatnagar et al 1999; Wang et al 2006). The significant correlation between higher knowledge scores and more favorable attitude scores established for teachers in the study area reemphasizes the positive relation between knowledge and attitude as noted by Chawla and Cushing (2007), Pe'er et al (2007), and Esa (2010).

Conclusions

Teachers working in Ladakh are well informed and show favorable attitudes toward conservation, except for snow leopards. During discussions with participants, older teachers were found to be a valuable source of traditional ecological knowledge. They can act as effective links between traditional and modern ecological knowledge. This capacity should be fully utilized to make the learning process interesting and to reinforce the importance of local-specific as well as global ecological knowledge. EE training for teachers should focus on local ecological systems, linking them to global systems, with emphasis on reducing unfavorable attitudes toward predator species of the region, especially snow leopards.

Informal discussions with government officials in the Jammu & Kashmir Education Department and the participant teachers have identified a number of limitations of implementing EE training programs. They include the overloaded school curriculum, a lack of financial support, essential facilities and resources, a high teacher-to-student ratio, lack of area-specific and area-appropriate instructional materials, and the remoteness of the rural communities. Despite these limitations, we suggest that both preservice and in-service EE programs should be prioritized for the education department and that such training should be compulsory for all science teachers and those living in remote places. Furthermore, once implemented, such training should subsequently be extended to nonscience teachers as well. We also recommend customized, mountain-specific EE courses for the regional teachers' training institutes to provide teachers with scientific ecological knowledge, aiming at building favorable attitudes and responsible behavior.

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Supplemental data

TABLE S1 Demographic attributes of the teachers from 10 administrative block headquarters of Ladakh, India.

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