

Conserving Biodiversity in the Indian Trans-Himalaya:

New initiatives of field conservation in Ladakh

*A Collaborative Project of
Wildlife Institute of India, US Fish & Wildlife Service
and International Snow Leopard Trust*



भारतीय वन्यजीव संस्थान
Wildlife Institute of India



International Snow Leopard Trust

Conserving Biodiversity in the Trans-Himalaya:

New Initiatives of Field Conservation in Ladakh

ACKNOWLEDGEMENTS

The project is indebted to the following for providing valuable guidance and logistical support during various stages of the work:

Mr. S.D. Swatantra, Chief Wildlife Warden, Jammu & Kashmir

Mr. S. Nagabhandari, Ex-Chief Wildlife Warden, Jammu & Kashmir

Mr. Navir Kitchloo, Regional Wildlife Warden, Jammu & Kashmir

Mr. Paul Zarger, Wildlife Warden, Leh

All staff of the Jammu and Kashmir Dept. of Wildlife Protection stationed in Ladakh

District Commissioner, Leh

SDM, Leh

Mr. Rajeev Kumar Tewari, DFO, Leh

Col. A.K. Singh, Ex-Director, Army Ecological & Environmental

Col. K.S. Gulla, Director, Army Ecological & Environmental

Lt. Col. D. Banerjee, GS

Field officers and jawans of the Indian Army in Changthang and Nubra

Commandant of the 3rd Battalion, Indo Tibetan Border Police

Field officers and jawans of the Indo Tibetan Border Police in Changthang

Mr. S.K. Mukherjee, Director, WII

Mr. Brad Rutherford, Executive Director, International Snow Leopard Trust (ISLT)

Dr. Tom McCarthy, Conservation Director, ISLT

Mr. Fred Bagley, US Fish and Wildlife Service

A Collaborative Project of

Wildlife Institute of India, US Fish &

Wildlife Service and International Snow Leopard Trust

Investigators

V.B. Mathur, Yash Veer Bhatnagar, Qamar Qureshi, R.S. Chundawat,

Rodney Jackson, Tom McCarthy and Don O. Hunter

Team Members & Research Components

G.S. Rawat, B.S. Adhikari, B.S. Rana¹ (Vegetation), C.P. Kala (Traditional Health Practices),

V.P. Uniyal (Insects), S.P. Vijayakumar, Karthik Vasudevan, B.C. Choudhury (Herpetofauna),

Pratap Singh, R. Jayapal (Birds), Yash Veer Bhatnagar, Rinchen Wangchuk² (Large Mammals),

S.A. Hussain, R.K. Singh (High Altitude Wetlands), R. Jayapal (People-Wildlife Conflicts)

Workshops

Yash Veer Bhatnagar, S. Sathyakumar, Rinchen Wangchuk (Snow Leopard Information Management System Techniques Training Workshop), S.K. Mukherjee, V.B. Sawarkar,

V.B. Mathur, Yash Veer Bhatnagar (Management Planning Workshop)

1: Himachal Pradesh Forest Department

2: International Snow Leopard Trust; Now with Snow Leopard Conservancy, USA

EXECUTIVE SUMMARY

ACKNOWLEDGEMENTS

The project is indebted to the following for providing valuable guidance and logistic support during various stages of the work:

Mr. S.D. Swatantra, Chief Wildlife Warden, Jammu & Kashmir

Mr. S. Naqshbandhi, Ex- Chief Wildlife Warden, Jammu & Kashmir

Mr. Nasir Kitchloo, Regional Wildlife Warden, Jammu & Kashmir

Mr. Rauf Zargar, Wildlife Warden, Leh

All staff of the Jammu and Kashmir Dept. of Wildlife Protection stationed in Ladakh

District Commissioner, Leh

SDM, Leh

Mr. Rajeev Kumar Tewari, DFO, Leh

Col. A.K. Singh, Ex-Director, Army Ecological & Environmental Cell

Col. K.S. Gulia, Director, Army Ecological & Environmental Cell

Lt. Col. D. Banerjee, GSO1 (Er.), 14 Corps

Field officers and jawans of the Indian Army in Changthang and Nubra

Commandant of the 3rd Battalion, Indo Tibetan Border Police

Field officers and jawans of the Indo Tibetan Border Police in Changthang

Mr. S.K. Mukherjee, Director, WII

Mr. Brad Rutherford, Executive Director, International Snow Leopard Trust (ISLT)

Dr. Tom McCarthy, Conservation Director, ISLT

Mr. Fred Bagley, US Fish and Wildlife Service

Mr. B.C. Choudhury, Nodal Officer, WII-US Fish and Wildlife Service

Mr. Navneet Gupta, Mr. Panna Lal and Mr. Rajesh Thapa, GIS Cell, WII

Mr. Rajeev Thapa, WII

Apart from the above there are many others in WII and outside who provided support to the project personnel and we are grateful to them.

EXECUTIVE SUMMARY

CONSERVING BIODIVERSITY IN THE TRANS-HIMALAYA: *New Initiatives of Field Conservation in Ladakh*

Investigators

V.B. Mathur, Yash Veer Bhatnagar, Qamar Qureshi, R.S. Chundawat, Rodney Jackson and Don O. Hunter

Team Members & Research Components

G.S. Rawat, B.S. Adhikari (Vegetation), C.P. Kala (Traditional Health Practices), V.P. Uniyal (Insects), S.P. Vijayakumar, Karthik Vasudevan, B.C. Choudhury (Herpetofauna), Pratap Singh, R. Jayapal (Birds), Yash Veer Bhatnagar (Large Mammals), S.A. Hussain, R.K. Singh (High Altitude Wetlands), R. Jayapal (People-Wildlife Conflicts)

Workshops

Yash Veer Bhatnagar, S. Sathyakumar (Snow Leopard Information Management System Techniques Training Workshop), S.K. Mukherjee, V.B. Sawarkar, V.B. Mathur, Yash Veer Bhatnagar (Management Planning Workshop)

The Indian Trans-Himalaya is endowed with rich and unique biodiversity. However, most of this has not yet been adequately studied or documented. The Wildlife Institute of India (WII), along with its collaborators, the US Fish and Wildlife Service (USFWS) and the International Snow Leopard Trust (ISLT) recognized this paucity of information and initiated a research programme by establishing a 'Collaborative Ladakh Field Research Station (CLFRS)' in Leh to carry out research and conservation activities in the Ladakh region of the Indian Trans-Himalaya. The programme is initially for a two year period from Oct 1999 till Sept 2001, and is likely to be continued for a further three years. During the first year, a series of baseline surveys were undertaken by WII scientists and researchers between June and August 2000 on eight components viz. vegetation, medicinal plants, insects, herpetofauna, birds, mammals, wetlands and socioeconomics. The surveys have revealed aspects of species presence and distribution, including range extensions, and potentially some new descriptions.

The vegetation survey described species composition and vegetation cover along an ca. 760 km long 'gradsect' from the Rohtang pass in the Pir Panjal range through Lahul, Changthang, to the Karakoram range in Nubra and also parts of the Kargil mountains. Distinct physiognomic units and communities along the latitudinal and altitudinal gradient have been described, including vegetation along high passes and high altitude lakes. In another component, forty three practitioners in local medicine called 'Amchis', were interviewed under the traditional health practices survey to gather information on the local medicinal plants, their status, uses and other

information pertaining to the practice of traditional medicine in Ladakh. The use of 286 plants, 38 animals and five minerals has been documented during the survey.

The insect and herpetological survey covered a wide range of altitude and plant communities from 2,800 m to 5,500 m. A variety of sampling techniques were tested. Approximately 30 families of insects, representing seven insect orders have been identified so far and the species level identification is in progress. A preliminary analysis of vegetation-insect community associations has also been carried out. The herpetofauna survey has identified six species of amphibians and reptiles belonging to six genera and five families. Descriptions of the species include data on morphometrics, habitat and distribution.

The bird survey covered eastern Ladakh and Zaskar regions of Ladakh, a region hitherto less studied. The survey recorded 97 of the 110 breeding bird species reported so far from Ladakh. The altitudinal distribution and habitat relationships of these species have been described along with some new breeding records and range extensions. Significant threats to the bird communities have been enumerated.

Under the large mammal survey a stretch of over 1,200 km of vehicular surveys in Eastern Ladakh was conducted to locate populations of the endangered species with a focus on kiang (*Equus kiang*), Tibetan argali (*Ovis ammon*), Tibetan gazelle (*Procapra picticaudata*), chiru (*Pantholops hodgsoni*) and wild yak (*Bos grunniens*). A survey of the Nubra region was undertaken to assess the status and distribution of the endemic Ladakh urial and a feral population of the Bactrian camel within the Karakoram wildlife sanctuary. Issues pertaining to the conservation of these endangered large mammals were identified.

The wetland team surveyed six high altitude lakes (Tso Moriri, Tso Kar, That Sang Karu, Kiyun Tso I, Kiyun Tso II and Pangong Tso) and major river systems (Indus, Nubra, Shyok, Zaskar and Suru) for their physicochemical properties. Water samples were analyzed on the spot for conductivity, total dissolved solids, salinity, pH, dissolved oxygen, nitrate, nitrite, ammonia, phosphate and sulfite. Information on the distribution and abundance of breeding birds along the lakes and status of otters along the rivers was collected for relating with habitat quality.

Under the Socio-economic survey, livestock depredations by wild predators in the Zaskar region were investigated and it was found that the Tibetan wolf was the primary predator in the region and that brown bears also were involved in some depredation cases.

Information regarding wildlife population and status from the PAs of Ladakh is very scarce and invariably outdated. We recognized that this emerged from lack of trained manpower and funds with the Jammu & Kashmir Wildlife Department, which is primarily responsible to collect such information from their PAs. In order to overcome this limitation to some extent, a group of ten frontline staff from the Jammu and

Kashmir Dept of Wildlife Protection were trained during 19-31 May 2000, in the use of wildlife monitoring techniques based on the Snow Leopard Information Management System (SLIMS) developed by the ISLT. After two days of lectures on various aspects of wildlife monitoring, hands-on training was provided when the entire team surveyed the Shang catchment of the Hemis NP.

There is an urgent need to discuss pertinent conservation issues relating to wildlife conservation in the Indian Trans-Himalaya and to develop guidelines for formulating Management Plans for the PAs in the Greater Himalaya and Trans-Himalaya, with special reference to snow leopard areas. This is crucial as a good Management Plan for a PA enables focussed and sustained efforts for conservation based on a workable vision. It is also felt that there is a need to encourage the Government to recognize the importance of Management Plans and to emphasize to the State and Central Governments the need for developing scientific PA Management Plans and also provisioning of separate funds towards implementation of these plans. As per this perceived need for scientific management of PAs in the Indian Trans-Himalaya, WII conducted a Management Planning Training Workshop in Ladakh under the CLFRS (25-29 August 2000). The programme for this workshop included three days of brief presentations and discussions by various resource persons regarding the conservation issues, existing scientific knowledge in the region, and possible management options. An exercise was also conducted on the management planning process for the Hemis NP, one of the prime snow leopard PAs in India. This was followed by a field trip to the Hemis NP by the team to obtain hands on experience of the issues on 28 and 29 August 2000. National and international wildlife experts, local governmental and non-government organizations participated in the workshop. The primary recommendation was the re-initiation of the 'Snow Leopard Scheme' or an equivalent programme by the Central Government that would provide better resources and a framework for tackling the complex conservation issues such as livestock grazing competition with wild herbivores and conflicts between people and wildlife.

4.4.5 Treatment by moxibustion and puncturing of veins	24
4.4.6 Use of plants	25
4.4.7 Use of animal parts	45
4.4.8 Use of minerals	47
4.4.9 Treatment by cold and hot water	47
4.4.10 Prescriptions for patient in TMS	48
4.4.11 Future of TMS	48
4.4.12 Best localities of medicinal plants in Ladakh	49
4.4.13 Status of rare and endangered medicinal plants of Ladakh	51
4.4.14 Conservation and management	52
Chapter 5 INSECT SURVEY IN LADAKH	54
5.1 Introduction	54
5.1.1 High altitude entomology: An overview	54
5.2 Objectives	55
5.3 Study Area	55
5.4 Methods	56
5.5 Significant Findings	56
5.6 The Future Plan	57

Table of Contents

Acknowledgements

Executive Summary

Chapter 1 BACKGROUND 1

Chapter 2 INTRODUCTION 3

Chapter 3 VEGETATION SURVEYS IN THE INDIAN TRANS-HIMALAYA 7

3.1 Introduction..... 7

3.2 Objectives..... 7

3.3 Methods..... 8

3.4 Results and Discussion 9

3.4.1 General physiognomy and vegetation cover 9

3.4.2 The habitat diversity and life forms 11

3.4.3 Endemic plants 12

3.4.4 Floristic structure and composition around high passes 12

3.4.5 Vegetation around a high altitude wetland 14

3.5 Conclusions 14

Chapter 4 A STUDY OF TRADITIONAL HEALTH CARE & MEDICINAL PLANTS . 16

4.1 Introduction..... 16

4.2 Study area 18

4.3 Methods..... 19

4.3.1 Survey of medicinal plants 19

4.3.2 Assessment of traditional knowledge among Amchis..... 19

4.4 Results and Discussion 20

4.4.1 History and evolution of TMS 20

4.4.2 Medicine Buddha 21

4.4.3 Profile of Amchis in Ladakh 21

4.4.4 Examination and pulse reading by Amchis 24

4.4.5 Treatment by moxibustion and puncturing of veins 24

4.4.6 Use of plants 25

4.4.7 Use of animal parts..... 45

4.4.8 Use of minerals..... 47

4.4.9 Treatment by cold and hot water 47

4.4.10 Prescriptions for patient in TMS 48

4.4.11 Future of TMS 48

4.4.12 Best localities of medicinal plants in Ladakh 49

4.4.13 Status of rare and endangered medicinal plants of Ladakh 51

4.4.14 Conservation and management 52

Chapter 5 INSECT SURVEY IN LADAKH 54

5.1 Introduction..... 54

5.1.1 High altitude entomology: An overview 54

5.2 Objectives..... 55

5.3 Study Area..... 55

5.4 Methods..... 56

5.5 Significant Findings..... 56

5.6 The Future Plan..... 57

Chapter 6	A PRELIMINARY SURVEY OF HERPETOFAUNA IN THE LADAKH REGION	63
6.1	Introduction.....	63
6.2	Study Area.....	63
6.3	Methods.....	64
6.4	Results and Discussion	66
6.4.1	Species inventory	66
6.4.2	Habitat, microhabitat and habit of herpetofaunal species.....	67
6.4.3	Species distribution in Ladakh.....	69
6.4.4	Probable threats.....	70
6.4.5	Miscellaneous notes	72
Chapter 7	A SURVEY OF BREEDING BIRDS OF LADAKH	74
7.1	Introduction.....	74
7.2	Ladakh: Biophysical Features	74
7.2.1	Location.....	74
7.2.2	Geology and soil.....	75
7.2.3	Climate.....	75
7.2.4	Flora.....	75
7.2.5	Birds.....	76
7.3	Objectives.....	77
7.4	Study Area.....	77
7.5	Materials & Methods of Survey	78
7.6	Species Accounts	79
7.7	Ecological Segregation of Some Selected Sister-Taxa	98
7.8	Similarity of Landscape Units in Their Bird Species Composition & Abundance	102
7.9	Significant Findings of The Survey.....	104
Chapter 8	STATUS SURVEY OF LARGE MAMMALS IN EASTERN LADAKH & NUBRA	108
8.1	Introduction.....	108
8.2	Study Area.....	109
	Block	109
8.3	Methods.....	110
8.4	Results and Discussion	110
8.4.1	Tibetan wild ass or kiang	111
8.4.2	Tibetan gazelle or Gowa.....	113
8.4.3	Tibetan argali or nyan	115
8.4.4	Tibetan antelope or chiru & wild yak or dong	116
8.4.5	Large carnivores.....	117
8.4.6	Livestock populations	117
8.4.7	Possible impacts of livestock grazing on wildlife	118
8.4.8	Bactrian camel.....	121
8.4.9	Ladakh urial.....	123
8.5	Conclusions and Recommendations.....	123
8.5.1	Monitoring.....	124
8.5.2	Other conservation action.....	125

Chapter 9	BENCH MARK ECOLOGICAL STATUS OF WETLANDS OF LADAKH	136
9.1	Introduction.....	136
9.2	Objectives.....	137
9.3	Study area	137
9.3.1	Lakes.....	137
9.3.2	Rivers	138
9.3.3	Description of the lakes	138
9.3.4	Description of the rivers	139
9.4	Methodology	140
9.4.1	Physicochemical analysis	140
9.4.2	Distribution of breeding birds	140
9.4.3	Distribution of otter	140
9.4.5	Extent of human use of wetlands/lakes.....	140
9.5	Results	141
9.7	Discussion	146
Chapter 10	PATTERNS OF LIVESTOCK DEPREDATION BY WILD ANIMALS IN ZANSKAR, LADAKH	150
10.1	Introduction	150
10.2	Objectives	151
10.3	Study Area	151
10.4	Survey Methods	152
10.4.1	Livestock in Zanskar	152
10.4.2	Wild predators of Zanskar	153
10.5	Results & Discussion	154
10.6	Conclusion	160
Chapter 11	MANAGEMENT PLANNING FOR TRANS-HIMALAYAN PROTECTED AREAS	164
11.1	Background.....	164
11.2	Workshop Objectives	164
11.3	Workshop Programme	165
11.4	Workshop Participants	165
11.5	Management Planning Process for Hemis National Park	165
11.5.1	Conservation values of Hemis National Park.....	165
11.5.2	Objectives of Management of Hemis National Park.....	165
11.5.3	Management Objectives – Problem matrix for Hemis National Park....	166
11.6	Workshop Recommendations	166
11.7	The Way Forwards.....	167

Chapter 1

Background

Ladakh constitutes over 80% of the Trans-Himalayan tract in India and is home to a unique assemblage of flora and fauna. Little information on the flora and fauna of Ladakh and other Trans-Himalayan areas of India exist. Recognizing this, and the long-term interest in the region, the Wildlife Institute of India (WII) and its collaborating agencies in the ongoing Himalayan Biodiversity Project (HBD), the International Snow Leopard Trust (ISLT) and the United States Fish and Wildlife Service (USFWS) initiated a collaborative programme to enhance conservation and research activities. The HBD project was successful in generating some information regarding mammal, bird and plant diversity from Ladakh, however other aspects of Ladakh's unique biodiversity remains largely unexplored. It was also felt that there was tremendous scope and need for conservation activities in Ladakh. It was thus decided to work on a collaborative effort that would provide basic infrastructure in Ladakh and allow work by a multidisciplinary team. After obtaining clearance from the Training Research, and Academic Council (TRAC) of WII, a MoU between the parties was signed. The Collaborative Ladakh Field Research Station (CLFRS), a four room office cum accommodation was hired in Oct 1999 at Leh. The collaborative project provides basic staff and other necessary facilities to scientists visiting Ladakh to carry out their work.

During the year 2000 baseline research on eight aspects of Ladakh's biodiversity and two training courses/workshops have been conducted under this program by over 15 faculty members and researchers from the Institute. The research included baseline surveys on vegetation, medicinal plants, insects, herpetofauna, wetlands, birds, rare mammals and people-wildlife conflicts. One workshop related to the training of the frontline staff in wildlife monitoring techniques and the other dwelt on the management planning of Trans-Himalayan PAs.

The Wildlife Institute of India has had a long-standing interest in Ladakh, however the primary region of focus has been part of the 3,350 km², Hemis NP. This area has been receiving continued research attention from WII since early 1980s and aspects pertaining to the biology of bharal, snow leopard, and the status and distribution of other wildlife have been dealt with in detail. During 1997 to 1999 the Institute conducted short surveys on the vegetation, birds and mammals of Ladakh in some regions under the Himalayan Biodiversity Project. However, some equally important areas in Ladakh have received little attention regarding research and conservation efforts so far from the Institute and other organizations in general. It was therefore proposed to take up such regions and cover hitherto less studied aspects helpful for biodiversity conservation in the region. Baseline research on eight components conducted during 2000 is to be continued until September 2001 under these and some additional components. Depending on the outputs in the initial two years it is proposed to continue research in a more focussed manner on selected issues. It is hoped that

the multidisciplinary research and training activity will significantly contribute in enhancing knowledge of the region and aid in the identification of gaps in PA coverage in Ladakh. This could ultimately lead to the development of a comprehensive conservation action plan for Ladakh Trans-Himalaya. Implementation of selected conservation initiatives will also be taken up under the CLFRS. The basic objectives of the programme are as follows:

1. To establish baseline status and distribution of different taxa from selected regions of Ladakh and gather baseline information on key socioeconomic parameters.
2. To create a spatial database in GIS domain.
3. To develop a detailed biogeographic classification and identify gaps in PA coverage in Ladakh.
4. To identify primary conservation issues in the PAs of Ladakh.
5. To develop a conservation action plan for Ladakh and take up the implementation of selected conservation initiatives.

We have got encouraging results towards achieving many of these objectives during the first year and the primary findings as individual reports by the involved scientists are compiled in this report.

Chapter 2

Introduction

The Himalaya extend for over 2,500 km along the northern frontier of India in one giant sweep from the Nanga Parbat massif in the west to the Namche Barwa in the east. North of this high range lies the Tibetan plateau that was mostly formed as a result of tectonic upliftment of the Tethes Sea in the Miocene and Pliocene period (Wadia, 1966). The region is also referred to as a 'cold-desert' and is characterized by severe, arid conditions, where temperatures may drop to -50°C in the long winter months between December and April, but rise to 35°C in the short summer season in July-August. Most precipitation is in the form of snowfall and there is insignificant monsoonal effect, its being in the rain-shadow of the Greater Himalaya. The vegetation in the region is sparse and productivity peaks only in the short summer season. This harsh environment is thus home to an array of highly adapted flora and fauna.

The Tibetan plateau region is very vast, and within India itself it extends for 1,84,823 km^2 in the states of Jammu & Kashmir, Himachal Pradesh and small portions in Sikkim and the Uttaranchal Mountains. About 60% of this region has been included under the biogeographic zone 1A or 'Ladakh Mountains', which includes the mostly rugged areas in the Kargil, Nubra and Zaskar in Ladakh and Lahul and Spiti in Himachal Pradesh (Rodgers *et al.* 2000). The remainder 40% of the region is the Zone 1B or the 'Tibetan Plateau' that occurs as high altitude plateaus with vast plains and rolling slopes in the Changthang region of Ladakh and the northern parts of Sikkim (Fig 1). Parts of the Kargil and Nubra region are as low as 2,200 m, but bulk of the region is above 4,000 m. This is especially so for the Changthang plateau, where the valleys and plains are itself at 4,000 m or above (Fig 1). The Trans-Himalayan region also provides the watershed of numerous wetlands - brackish and freshwater lakes, marshes and river systems. In Ladakh the Indus River and its primary tributaries - the Zaskar and Shyok Rivers form the primary drainage. Large lakes such as Tso Moriri, Tso Kar and Pongong Tso are distributed along with numerous smaller ones in eastern Ladakh. Apart from their hydrological importance, the wetlands are home to a rich variety of waterfowl.

A recent database of Trans-Himalayan plants developed by WII puts the number of flowering plants at c. 600, many of which have medicinal properties. Asteraceae and brassicaceae are the dominant families. Most plants have developed adaptations to survive in the severe cold and arid conditions with life forms such as cushionoid, wooly and prostrate (refer Chapter 3). Although sparsely distributed, most plants in the Trans-Himalaya have some ethnobotanical significance and are crucial to the indigenous people as livestock forage, fuel, medicine or food (refer Chapter 4). Thus their conservation is extremely important for the people and the varied range of wildlife that are sustained by it.

Over 225 bird species are known to occur in the Trans-Himalaya, most common among these are the finches (Passeridae and Fringillidae) and larks (Alaudidae) (refer Chapter 7). During summer many of the water bodies in Ladakh attract migratory waterfowl such as the endangered bar-headed geese and great-crested grebe (refer Chapter 7 & 9). Another prominent bird migrating into Ladakh is the black necked crane, of which the numbers have constantly dwindled and only 8 - 11 pairs may now visit various marshes in eastern Ladakh.

Large mammal fauna of the region have a strong palearctic influence with species that include the endangered snow leopard, Tibetan antelope or chiru, Tibetan argali, Tibetan gazelle, among others (refer Chapter 8). There are 15 species that are included in the Schedule I and II of the Indian Wildlife (Protection) Act 1972 (Anon. 1992). The IUCN Red Lists and CITES also include many of these species and tremendous conservation efforts are needed for species such as snow leopard, chiru, Tibetan gazelle and argali. One of the oft-unrecognized facts about the Trans-Himalaya is that it has six species and subspecies of wild sheep and goats and is an important reservoir of genetic material for any future improvement of domestic stock. Unfortunately, little information is available even on the status and distribution of these species let alone detailed accounts on their ecology.

On other lower taxa such as insects (refer Chapter 5), fishes, and herpetofauna (refer Chapter 6) little or no information exists and its important to study their role in the ecosystem and threats originating from changes in landuse.

At present there are seven Protected Areas (PAs) in the Indian Trans-Himalaya that cover c. 17,000 km² or 9.2 % of its geographical area (Rodgers *et al.* 1999). These include three National Parks (NP) that cover 3.5 % of the area and four wildlife sanctuaries (WLS) covering 5.7 % of the geographical area of the Trans-Himalaya. This seemingly large coverage is offset by the fact that Trans-Himalaya does not have any 'Reserve Forests' to buffer human pressures on the PAs and that up to 60 % of some PAs may actually have uninhabitable terrain such as glaciers and sheer rock faces.

Apart from the harsh climate the Trans-Himalaya have another characteristic, that the resources for the indigenous people are very sparse and that almost any given corner of the region that can support humans already has some level of use by humans. People inhabiting the region occur in sparse densities of 1 - 2 /km² and are mostly agro-pastoralists, and in the eastern Ladakh plains, largely follow nomadic pastoralism. Only one crop in a year can be grown in most parts and the primary crops grown are barley and a local variety of peas. Arable land is limited to some alluvial fans and valley bottoms only where irrigation is possible. The per capita livestock holding in Ladakh is 3, while the household wise holding is about 15-20 livestock heads (Anon. 1998). Many pastoralists in eastern Ladakh often have over 1,000 livestock, mostly sheep and goats. The livestock now command better value due to increased demand for wool, meat and draught related with activities of the Defense forces and tourists. This is probably the primary force behind an increase in the

together compare the Ladakh region.



livestock populations in the region (refer Chapter 8). People inhabiting most of Ladakh, Lahul-Spiti and Sikkim follow Tibetan Buddhism that includes a strong ethos of respect for life. However, with increased dependence on cash economy and under the influence of market forces attitudes are changing and reports of conflicts with wildlife are on the increase (refer Chapter 10). Apart from agro-pastoral activities and tourism-related work, there are few alternative occupations for the local people and this poses a significant problem when designing any conservation plan for the region.

Information regarding wildlife population and status from the PAs of Ladakh is very scarce and invariably outdated. We recognized that this emerged from lack of trained manpower and funds with the Jammu & Kashmir Wildlife Department, which is primarily responsible to collect such information from their PAs. In order to overcome this limitation to some extent, a group of ten frontline staff from the Jammu and Kashmir Dept of Wildlife Protection were trained during 19-31 May 2000, in the use of wildlife monitoring techniques based on the Snow Leopard Information Management System (SLIMS) developed by the ISLT. After two days of lectures on various aspects of wildlife monitoring, hands-on training was provided when the entire team surveyed the Shang catchment of the Hemis NP.

There is an urgent need to discuss pertinent conservation issues relating to wildlife conservation in the Indian Trans-Himalaya and to develop guidelines for formulating Management Plans for the PAs in the Greater Himalaya and Trans-Himalaya, with special reference to snow leopard areas. This is crucial as a good Management Plan for a PA enables focussed and sustained efforts for conservation based on a workable vision. It is also felt that there is a need to encourage the Government to recognize the importance of Management Plans and to emphasize the need for developing scientific PA Management Plans with provisioning of special funds towards their implementation. As per this perceived need for scientific management of PAs in the Indian Trans-Himalaya, WII conducted a Management Planning Training Workshop in Ladakh under the programme (25-30 August 2000). This workshop included three days of brief presentations and discussions by various resource persons regarding the conservation issues, existing scientific knowledge, and management options. This was followed by a field trip to the Hemis NP by the team to obtain hands on experience of the issues on 28 and 29 August 2000 (refer Chapter 11).

In order to allow suitable conservation of wildlife and natural resources in the region the ecological attributes need to be assessed and conservation activities carried out with sensitivity to the local environmental and cultural conditions. The endeavor of the three collaborating partners in the present project – Wildlife Institute of India (WII), International Snow Leopard Trust (ISLT) and the US-Fish and Wildlife Service (USFWS) is to fill in this gap in both, availability of information and conservation planning from the region. A sum of Rs. 500,000 or US\$ 11,111 (@US\$ 1 = Rs 45) has been contributed by the three collaborative partners to fund the activities of CLFRS. The focus of the present effort is in Ladakh; however, our hope is that many of the findings will help in the preparation of effective conservation action plans for other similar regions within India.

This report is a compilation of findings on the eight research components and a workshop, carried out during the first year (2000). These are included as separate chapters authored by the scientists who conducted the research activity. The selected aspects of research were those that were hitherto less studied and will help in establishing a baseline regarding the status and abundance of wildlife in the region. Given the diversity of subjects and scientists involved in the project, individual styles have been retained. It may also be noticed that the available information on different subjects also greatly varied and thus, the scope of each chapter is different.

Reference

- Anon. 1992. The Wildlife (Protection) Act 1972 (as amended upto 1993). Natraj Publishers, Dehradun. p. 158.
- Rodgers, W.A., H.S. Panwar and V.B. Mathur (2000). *Wildlife Protected Area Network in India. A review (Executive Summary)*. Wildlife Institute of India, Dehradun. 44p.
- Wadia, D. 1966. Geology of India. Macmillan. London.

Vegetation Surveys in the Indian Trans-Himalaya

by G.S. Rawat, B.S. Adhikari & B.S. Rana

3.1 Introduction

The rain shadow zone in the north of the Great Himalayan range is generally referred as the Trans-Himalaya or 'cold desert' and represents an interesting biome. The vegetation and plant life in this zone partly resembles those of other alpine regions, but largely differs in terms of physiognomy, cover and adaptability to environmental and biotic factors.

The flora and vegetation of Indian Trans-Himalaya are of considerable interest both from biogeographic as well as ecological points of view. Although this area is generally considered as floristically impoverished as compared to the areas of same altitudes in main Himalayan ranges (Mani, 1978, Schweinfurth 1984), it represents characteristic elements from nearby phytogeographic regions such as the alpine zone of the Greater Himalaya, Afghanistan, Tibet and Siberia (Kachroo *et al.*, 1977). The vegetation of this region has been described by earlier authors under various types such as *Caragana - Lonicera - Artemisia* formation (Osmaston 1922), Zone of dry bushes (Nakao 1955), Alpine steppe (Schweinfurth 1957), Dry alpine scrub (Champion & Seth 1968) and Alpine stony deserts (Puri *et al.*, 1989). Although, a large number of floristic and faunal surveys have been conducted in this region detailed analysis of the plant communities with respect to changing altitude and latitude is lacking. No comprehensive account of key floral elements and distribution of major growth forms within various sub-regions viz., Lahul, Zaskar, Changthang, Ladakh, and Karakoram ranges is available. Most of the area within this zone is under heavy grazing pressure by the migratory as well as resident livestock. There is a need to assess the general condition of vegetation i.e. Trans-Himalayan rangelands and also identify unique vegetation communities from the area so as to formulate a conservation plan. Therefore, the present survey was conducted in the region during the summer of year 2000.

3.2 Objectives

The survey was conducted with the following major objectives:

- (i) To classify and characterize the major physiognomic units of vegetation within the Indian Trans-Himalaya along Rohtang – Leh - Karakoram Gradsect.
- (ii) To compare the proportions of various growth forms within and between major Trans-Himalayan ranges viz., north of Pir-Panjal (Lahul), Zaskar, Changthang, Ladakh, and Karakoram.

- (iii) To compare the patterns of species richness and diversity among the high altitude passes.
- (iv) To assess the condition of Trans-Himalayan rangelands and identify the threats, if any.

3.3 Methods

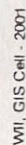
The vegetation parameters and dependent variables were sampled systematically along a **GRADSECT** (*Gradient Directed Transect*) following Austin & Heylingers (1989) and Gillison & Brewer (1985). Specific methods for the characterization of major physiognomic units, quantification of major growth-forms (cover abundance), species diversity along the high passes, and assessment of rangelands (alpine pastures) in various areas were as follows:

- i) The major physiognomic units of vegetation were recorded on either side of the survey route within 2 km x 100 m segments (strips). For this purpose we used a vehicle (with two observers for each side) driven at a uniform speed of 15-20 km/hour. For each two-km segment, major physiognomic types, % area under such types, major landforms, general remarks such as land use practice/anthropogenic pressures, altitudinal range, and species and number of livestock were recorded. The physiognomic units recorded were: Herbaceous meadow (HM), Sedge meadow (SM), Mixed scrub or steppe (MS), Riverine scrub (RS), Sparse vegetation including degraded slopes (SV), Woodland/Plantation (WP), Cultivation/Habitation (CH), Grasslands i.e. area dominated by grasses (GR), and cushionoid vegetation including mosses and lichens (CV).
- ii) Major plant communities were recorded systematically at a regular interval of 2 kms. At each sampling point (on either side of the road, sufficiently away from the visible impacts of the road) site characteristics such as aspect, altitude, terrain type, slope category and general vegetation cover were recorded. At each site five random plots of 3 m radius were laid to record the % cover of individual shrub species and their number. Concentric to each circular plot quadrates of 1 m² were laid to estimate the % cover of other life forms viz., grasses, sedges, herbs, mosses, ferns, and lichens. In addition, % area under barren rocks and soil were also recorded. Occurrence of any rare, threatened or valuable plants (including medicinal) were also recorded within the larger plots.

In all, 469 strips (belt transects along the survey route; 2km long and 100m wide) were laid for the classification of physiognomic units. The number of such transects in Greater Himalaya, Lahul, Zaskar, Changthang, Indus and Nubra region were 4, 55, 83, 117, 137 and 73, respectively. The survey route and important locations have shown in Fig 1.

The data for objective no. 4 was collected during the survey and intensive sampling for this objective would be collected during the summer of 2001.

37° 5' 13" + 80° 20' 45" +



- iii) Vegetation structure and species diversity around passes, viz., Rohtang, (3978 m), Baralacha La (4800 m), Lachulung La (5065 m), Tanglang La (5360 m), and Khardung La (5400 m) and banks of a brackish water lake (Tsomoriri) were studied using stratified random samples. Major strata included important aspects and land forms and within each stratum minimum of 10 random quadrats of 1x1m were laid following standard phytosociological approach (Mueller-Dombois & Ellenberg 1974, Bonham 1988). Plant species, their abundance and overall cover were estimated. The density following Misra (1968) and different diversity indices were calculated using STATECOL programme (Ludwig & Reynolds 1988). In addition, soil samples from each high pass were collected for chemical analysis.
- iv) General information on the condition of rangelands based on the predominance of various plant species, grazing pressure by the livestock and indirect use by the wild herbivores were recorded all along the survey route.

3.4 Results and Discussion

3.4.1 General Physiognomy and Vegetation Cover

The vegetation within the Great Himalayan range (around Rohtang pass) was dominated by the herbaceous meadows (ca. 55 %) followed by mosses (13 %), sedges (8 %), grasses (4 %) and lichens (3 %). The mean ground cover in this sector was about 83 %. The barren rocks and exposed soil covered about 9 and 8 %, respectively. The vegetation cover in relation to major physiognomic units of survey area in the Indian Trans-Himalaya is given in Table 1. The sector-wise description is as follows:

- i. As expected, the areas immediately north of Rohtang pass have strong affinities with the vegetation of Greater Himalaya in terms of species composition and cover largely due to greater influence of monsoon and topography. This area forms the gateway of migratory livestock to Lahul & Spiti from the lower parts of Kullu district. A few remnant patches of birch - rhododendron (*Betula utilis*-*Rhododendron campanulatum*) indicate that the vegetation in this area has undergone tremendous changes due to anthropogenic pressures including excessive trampling by livestock, and tourists as well as due to construction of temporary shops around Rohtang pass. The cover percentage of different life forms with respect to places is shown in Fig. 2a.
- ii. The hill slopes on either side of Chandra and Bhaga rivers have been intensively used by the local people for cultivation and livestock grazing. In recent years a considerable area has been brought under cultivation for cash crops such as pea (*Pisum sativum*) and potato (*Solanum tuberosum*). Cultivation of steep hill slopes is likely to aggravate soil erosion in the area. The cover percentage of different life forms with respect to places is shown in Fig. 2a.

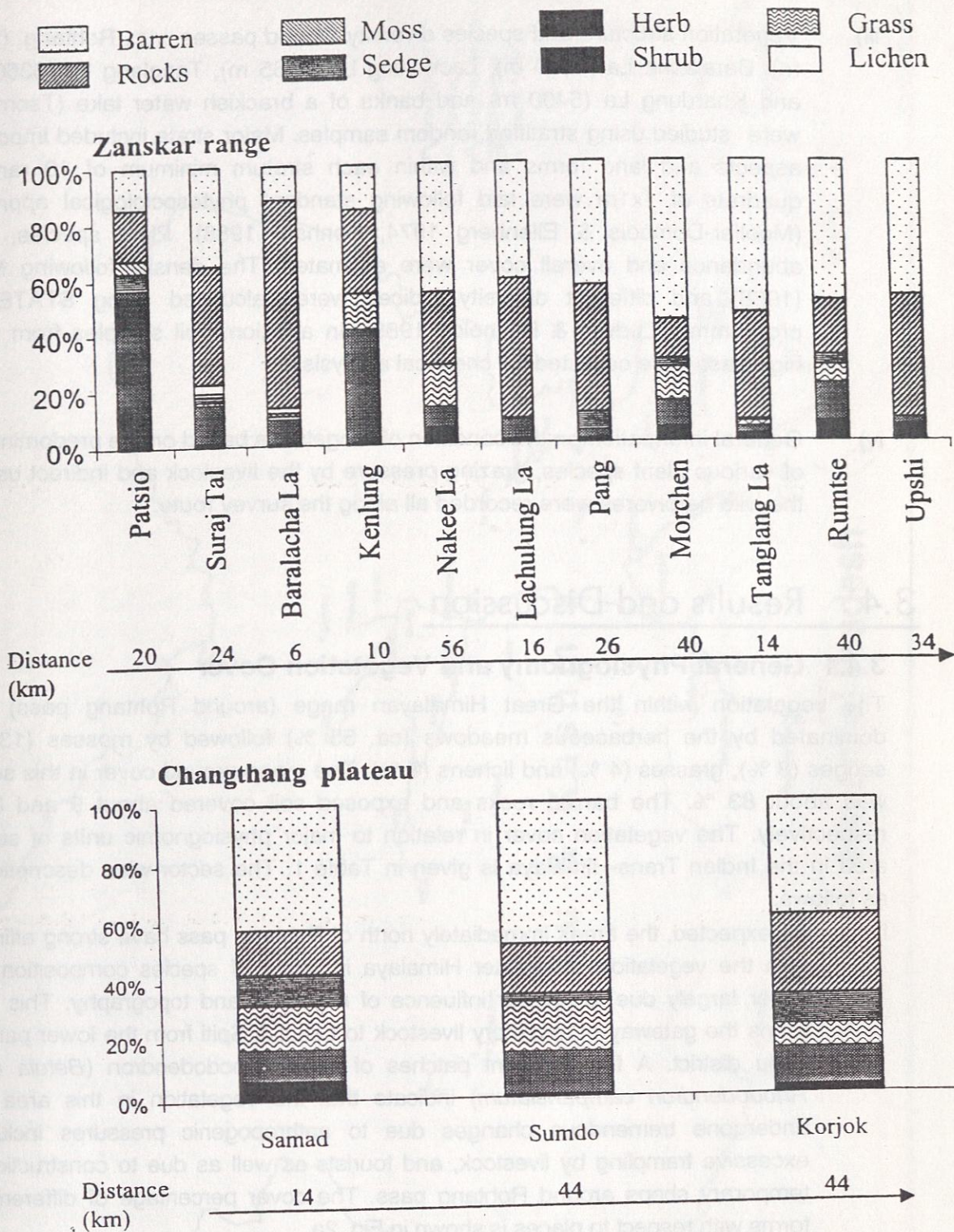


Fig. 2a: Percent cover of different life forms

- iii. The sector between Keylong and Darcha supports juniper (*Juniperus macropoda*) woodland, patches of willow (*Salix alba*) plantations near habitations, and *Artemisia* scrub. The hill slopes beyond Darcha up to Patsio were mainly dominated by two species of *Artemisia* viz., *A. dracuncululus* and *A. maritima*. The former occupies the gentle and smooth slopes while the latter is found on rocky and hard substrates. Both are less palatable by the livestock. The slopes around Patseo and areas beyond Baralacha La (up to Sarchu) are grazed by over 5000 sheep and goats during summer months. Most of the shepherds in this area come from Chamba district of Himachal Pradesh who feel that livestock grazing is no more profitable. A couple of the *Gaddi* pastorals have resorted to opening temporary *Dhabas* (restaurants) in this area as there has been a sudden increase in the number of tourists traveling through this area. The cover percentage of different life forms with respect to places is shown in Fig. 2a.
- iv. The area around Suraj Tal, Baralacha La, Kinlung Sarai, Sarchu, Lachulung La and other prominent places are heavily degraded as seen by the heaps of non-degradable garbage (such as used tar-coal drums, damaged construction material, and liquor bottles), and excessive trampling near camping sites. The Border Road Organization (BRO) and Department of Tourism (both HP and J&K) could play very important role in clearing the garbage and maintenance of wilderness in the area. The cover percentage of different life forms with respect to places is shown in Fig. 2a.
Overall, the Zaskar region had the highest percent cover of herbs at and around Kenlung and Patsio, grass cover between Kenlung and Nakeela, sedge cover at Pang and Patsio, and lichen cover between Suraj tal and Baralacha la areas.
- v. The Changthang plateau (including More plains) is extensively grazed by livestock (yak, sheep, goats, horses and donkeys) belonging to nomadic herders. The major vegetation communities in this area include sedge meadows, *Artemisia*–*Caragana* steppe, *Stipa* grasslands and sparse herb-grass-sedge (mixed) formations. Owing to relatively large area and rotational nature of grazing this plateau appears to be relatively less degraded compared to the parts of Lahul and other areas in the trans-Himalaya. Signs of degradation in the form of *Caragana* removal (for fuel wood) and lowered vegetation cover can be noticed mainly close to camping sites. Further studies on the ecology of rangelands in this area would be essential to understand the status of these areas. The cover percentage of different life forms with respect to places is shown in Fig. 2a.
In general, the cover percentage of sedges, grasses and herbs were more or less similar throughout the region.
- vi. The vegetation communities along the course of the Indus river are represented by patches of marsh meadows, willow plantations near habitation, and sparsely distributed shrubs such as *Ephedra gerardiana*, *Capparis wightiana*, *Lysium ruthenicum*, *Peganum harmala* and *Stachys tibetica*. The cover percentage of different life forms with respect to places is shown in Fig. 2b.
The cover percentage of lichens was high at and around Darkit and Kargil, herbs at Darkit and Wakha, while shrubs percentage was more or less similar throughout the region.

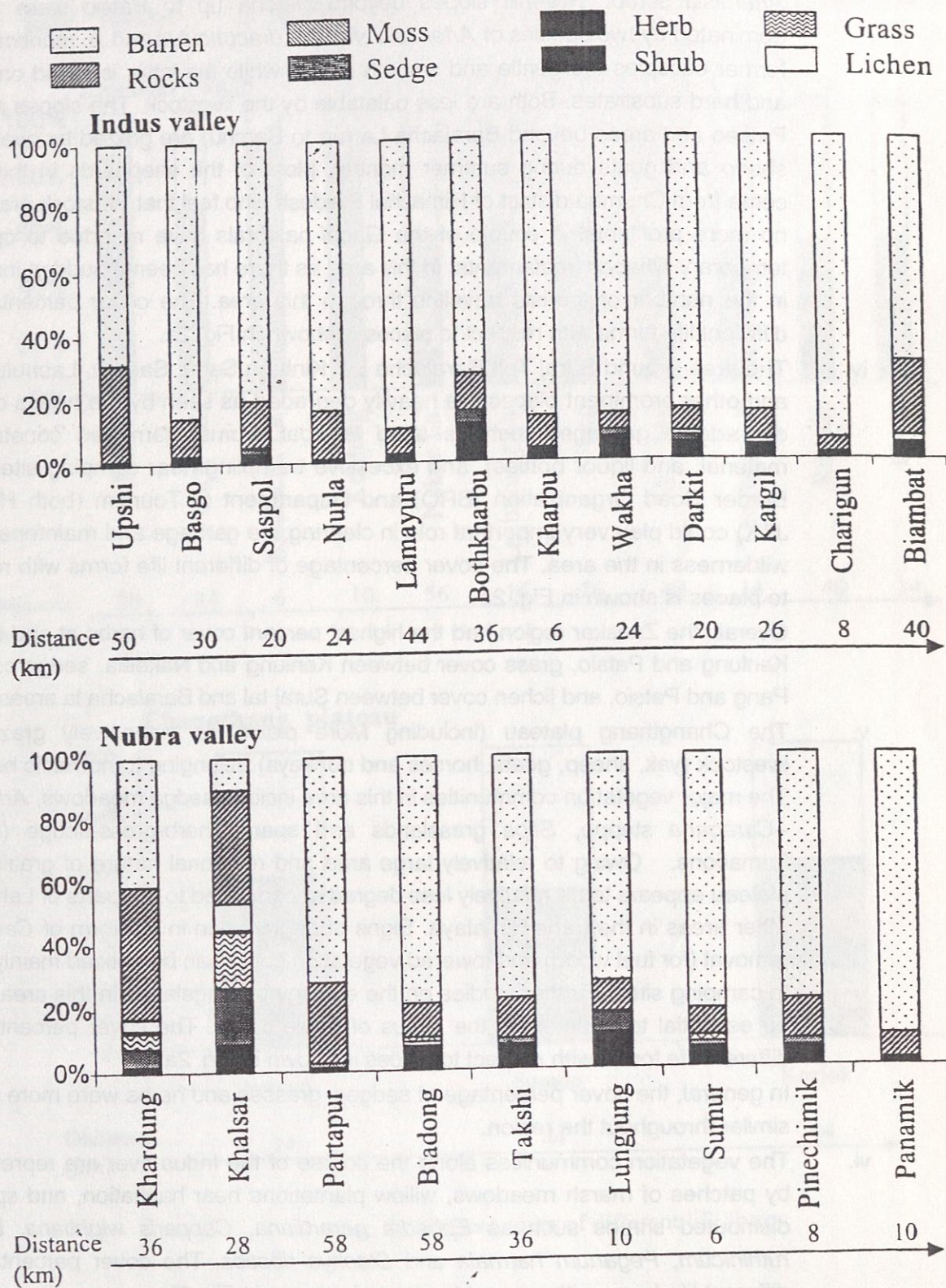


Fig. 2 b: Percent cover of different life forms

- vii. In Nubra valley the vegetation was mainly represented by willow and *Hippophae turkestanica* plantations along the agricultural fields and on flat lands, respectively. However, in gentler slopes, on flat land areas and rocky slopes the vegetation was sparsely distributed which was mainly dominated by shrub species such as *Rosa webbiana*, *Lycium ruthenicum* and *Sophora moorcroftiana* etc. The cover percentage of different life forms with respect to places is shown in Fig. 2b.

The cover percentage of grasses was high at and around Khalsar, lichens in between Khalsar and Khardung, while herb and shrub percentages were more or less similar throughout the region.

Table 1 Vegetation cover (%) in relation to physiognomic units in different zones

Physiognomic Unit	Cover percentage							
	HM	SM	MS	RS	SV	WP	CH	GR
Rohtang	100	-	-	-	-	-	-	-
Lahul	4.5	3.6	51.8	13.6	4.5	4.5	16.4	0.9
Zaskar	4.2	17.5	41.6	3.0	19.9	4.8	9.0	-
Changthang	2.6	43.6	14.1	-	7.3	-	7.3	25.2
Indus	0.7	15.0	37.6	1.1	23.7	1.1	0.1	6.6
Nubra	4.8	3.4	43.8	2.1	19.9	10.3	2.7	1.4

HM: Herbaceous meadow

SM: Sedge meadow

MS: Mixed scrub/steppe

RS: Riverine scrub

GR: Grasslands

SV: Sparse vegetation

CH: Cultivation/Habitation

WP: Woodland/Plantation

It was evident from the survey that Indus valley had lowest vegetation cover followed by Nubra, Changthang and upper Lahul. Changthang plateau exhibited most uniformly distributed vegetation communities owing to relatively even topography.

3.4.2 The habitat diversity and life forms

The habitat features (both macro and micro) across the landscape in the survey area varied considerably according to the topographic and hydrological features. The important habitat types and their characteristic floral elements are as follows:

i. **Riverine areas:** Valley bottoms are characterised by the presence of agencies such as *Hippophae* - *Myricaria* association, *Salix daphnoides*, *Phragmites karka* and *Equisetum*.

ii. **Field borders and valley bottoms:** The cultivated fields are usually located in the valley bottoms and are well irrigated. A large proportion of the flora is therefore, associated with this habitat. Common species include: *Capsella bursa-pastoris*, *Lindelofia anchusoides*, *Scopolia lurida*, *Tanacetum artemesioides*, *Nepeta floccosa*, *Potentilla nivea*, *Euphorbia tibetica*, *Lancea tibetica*, *Iris ensata*, *Carum carvii*, *Lepidium apetalum*, *Peganum harmala*, *Stachys tibetica* etc.

iii. **Marsh Meadows:** The valley bottoms with considerable amount of moisture are characterised by *Catabrossa aquatica*, *Chaerophyllum villosum*, *Euphrasia vulgaris*, *Pedicularis longiflora*, *Juncus* spp, *Carum carvii*, *Veronica beccabunga*, etc.

iv. **Moist slopes:** These are found in north facing slopes close to the glaciers and are characterised by the alpine mesophytic elements e.g. *Delphinium*, *Potentilla*, *Leontopodium*, *Taraxacum*, *Aster*, *Polygonum*, *Astragalus*, *Poa* etc.

v. **Eastern plains:** Large, flat areas close to Tibetan plateau are distinct in the vegetation composition. Characteristic species include: *Carex nivalis*, *Oxyria digyna*, *Polygonum*, *Draba lasiophylla*, *Sedum ewersii*, *Oxytropis lapponica*, *Potentilla multifida*, *Nepeta tibetica*, *Plantago minima*, *Lychnis macrorhiza*, *Atriplex crassifolia*, *Polygonum sibiricum*, *Sedum tibeticum*, *Arabis tibetica*, *Corydalis crassifolia*.

vi. **Rubble slopes and screes:** The rubble slopes and stable scree areas are characterised by the species like *Axyris amaranthoides*, *Crepis tenuifolia*, *Oxyria digyna*, *Thermopsis inflata*, *Euphorbia tibetica*, *Lagotis globossa*, *Rheum tibeticum*, *R. webbianum*, *Saussurea tibetica*.

vii. **Snowline zone:** Extreme altitudes along perpetual snow (5200 - 5500 m asl) are with a very short growing season, and very poor in species diversity. A few species of this zone are *Sedum ewersii*, *S. tibeticum*, *Draba* spp., *Arenaria kashmirica*, *Christolea himalayensis*, *C. crassifolia*, *Chorispora subulosa*.

3.4.3 Endemic plants

Following species, endemic to Tibetan plateau were recorded during the survey. *Corydalis adiantifolia*, *C. tibetica*, *Braya aenea*, *Capsella thomsonii*, *Dianthus deltoides*, *Stellaria tibetica*, *Astragalus ciliolatus*, *A. melanostachys*, *A. oxydon*, *A. tribulifolius*, *Sedum crassipes*, *Chrysanthemum tibeticum*, *Crepis stoliczkae*, *Inula falconeri*, *Leontopodium nanum*, *Saussurea subulata*, *S. thomsoni*, *Senecio tibeticus*, *Tanacetum artemesioides*, *Acantholimon lycopodioides* and *Waldhemia nivea*.

3.4.4 Floristic structure and composition around high passes

The high mountain ranges are known to act as barriers in the distribution of many plant (and animal) species. The Rohtang - Nubra Gradsect encompasses distinct valleys, plateaus and ridge systems. It is expected that the vegetation around major ridges and high passes would be significantly different from the valleys (owing to higher altitude and harsh climatic conditions) and it would mark the transition in the phytogeographic sub-divisions (if such distinctions occur) within the Trans-Himalaya. It may be pointed out that several plant species those are dispersed by domestic livestock (mainly sheep and goats) may not show any distinct pattern along the high passes.

These passes were dominated by *Polygonum* - *Anaphalis* - *Kobresia* (Rohtang), *Carex infusca* - *Waldhemia glabra* (Baralacha La), *Saussurea gnaphaloides* - *Carex microglochin* (Lachulung La), *Kobresia pygmaea* - *Saussurea gnaphaloides* (Tanglang La) and *Waldhemia tomentosa* - *Saussurea gnaphaloides* (Khaldung La) communities (Table 2).

The average density, species richness and diversity of herbaceous vegetation in different high passes is given in Table 2.

Table 2 Average density, species richness (SR), diversity and distribution pattern of vegetation in different high passes

Pass	Density (individuals m ⁻²)	SR (number)	Diversity (Shannon & Weiner 1963)	Evenness (Simpson 1949)
Rohtang	471 ± 109.9	41 ± 3.8	2.388 ± 0.31	0.643 ± 0.09
Baralacha	238.1 ± 106.7	31 ± 0.8	2.379 ± 0.13	0.693 ± 0.05
Lachulung	38.7 ± 9.1	14 ± 1.3	1.890 ± 0.10	0.716 ± 0.03
Tanglang	61.4 ± 25.2	15 ± 2.1	1.853 ± 0.38	0.684 ± 0.17
Khardung	35.0 ± 13.4	11 ± 1.9	1.842 ± 0.42	0.768 ± 0.20

Rohtang had highest vegetation cover (72.6%) followed by Baralacha La (20.1%), Tanglang La (9.3%), Lachulung La (7.5%) and Khardung La (1.0%). This pattern largely reflects the effect of altitude, topography and moisture gradient because the combined effect of these factors lead to low availability of nutrients and soil.

The physico-chemical properties of the soil at different passes are shown in box and whisker plots through SPSS (Figs. 3 a & b), which indicate the distribution of points in an descriptive manner. A thick line within the box represent the median, the box indicates 50% of values and whiskers denotes the distribution of points (above and below median) and outliers are also pointed out. The textural properties (sand, silt and clay) for all the passes differ from each other. With increasing altitude the percentage of sand also increased and percentage of silt decreased. The pH was more or less same for Lachulung and Tanglang passes but differed for other passes. However, moisture and water holding capacity of the soil was more or less same for all passes, except Rohtang. Among soil nutrients carbon and nitrogen for all passes was more or less same, except Rohtang, while all passes showed wide variations in the potassium and phosphorus values.

The analysis of the data on the floristic structure reveals that the similarity based on species number (i.e. qualitative) and based on species density (i.e. quantitative) were high between Lachulung and Tanglang among the five passes (Tables 3 & 4). This may be due to less water holding capacity, carbon and nitrogen and high pH value of the soil.

Table 3. Similarity (*qualitative*) between high passes

Pass	Rohtang	Baralacha	Lachulung	Tanglang	Khardung
Rohtang	100				
Baralacha	11.0	100			
Lachulung	7.3	22.2	100		
Tanglang	3.6	21.7	62.1	100	
Khardung	3.6	19.0	16.0	23.1	100

Table 4. Similarity (*quantitative*) between high passes

Pass	Rohtang	Baralacha	Lachulung	Tanglang	Khardung
Rohtang	100				
Baralacha	1.0	100			
Lachulung	1.0	9.0	100		
Tanglang	0	5.0	39.0	100	
Khardung	0	2.0	18.0	21.0	100

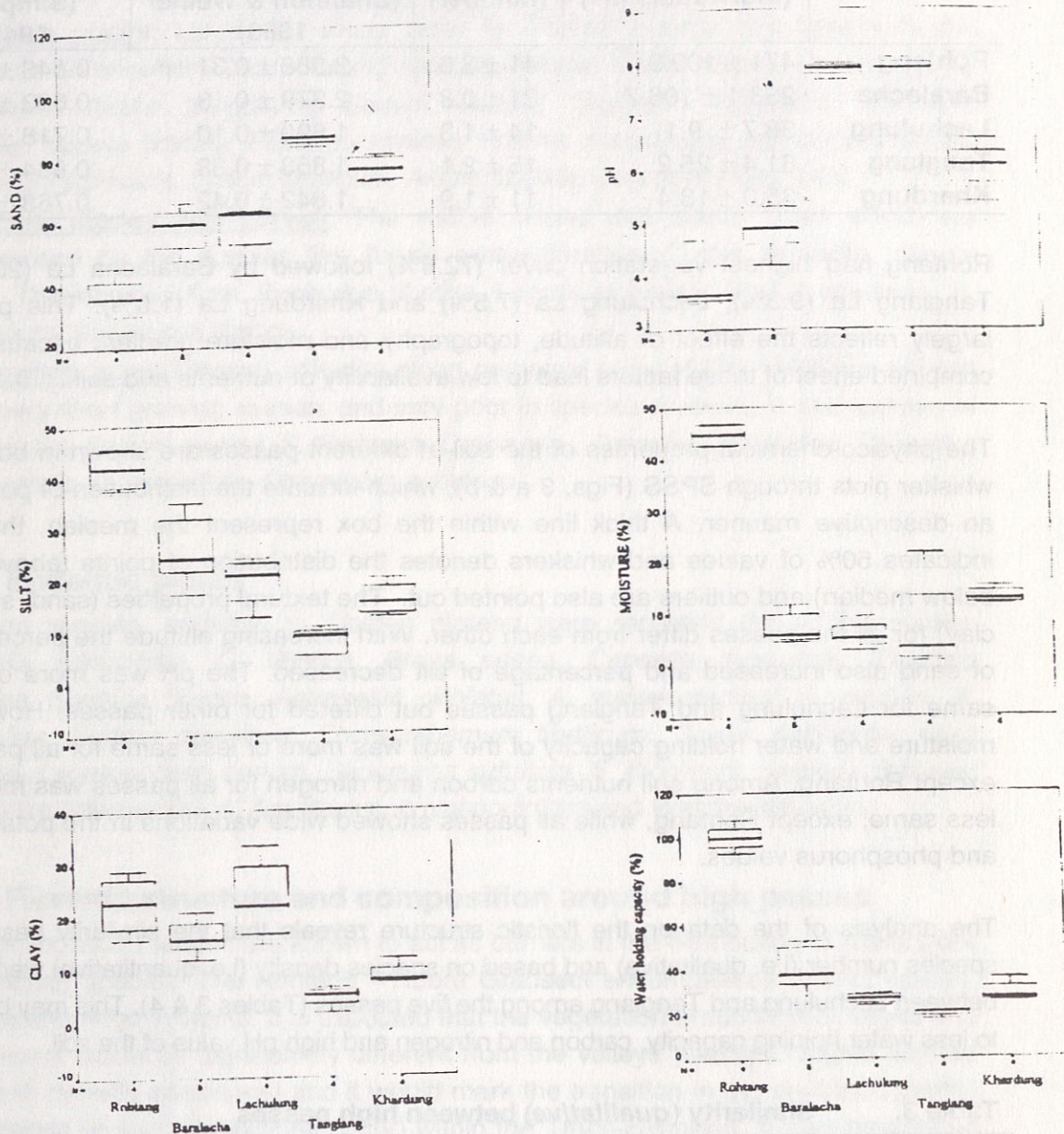


Fig 3a. Variations in soil texture (clay, silt, sand in %), pH, moisture (%), and water holding capacity (%) of soil at different passes.

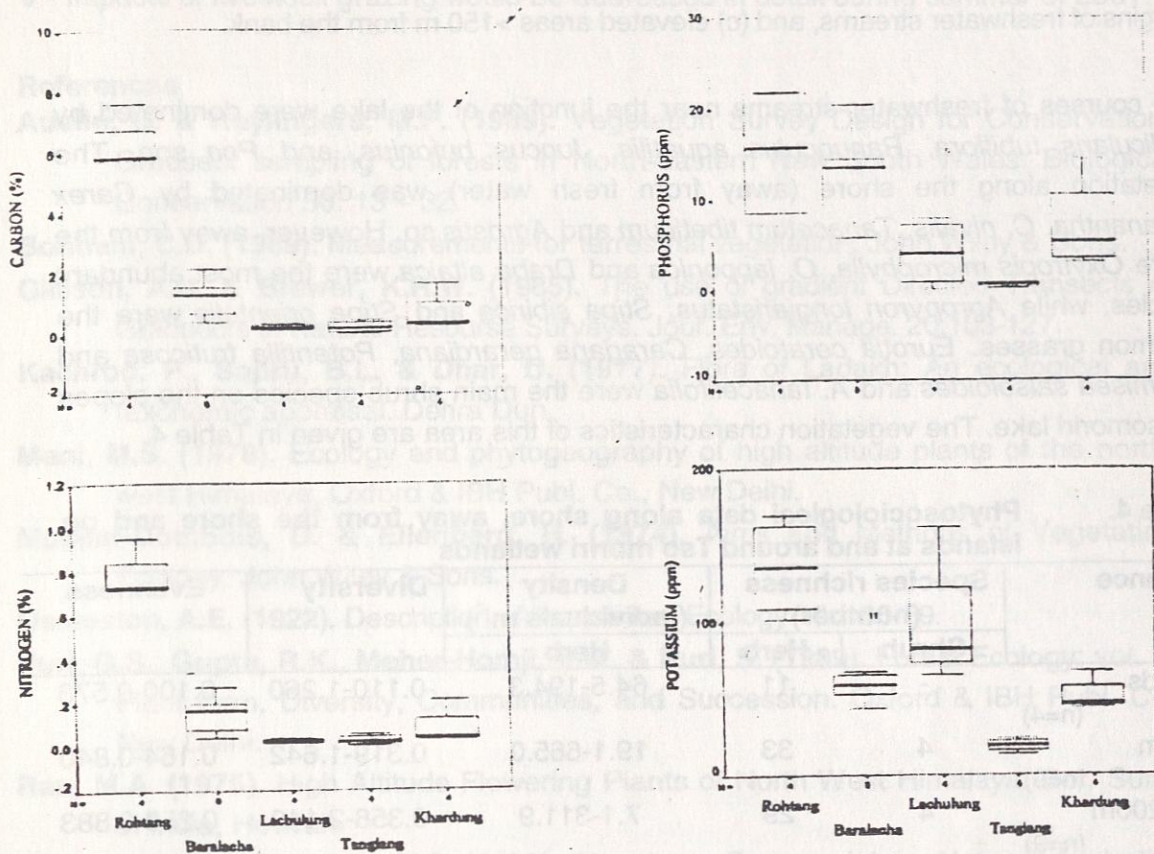


Fig 3b. Variations in carbon, nitrogen, phosphorous and potassium in soil at different passes.

3.4.5 Vegetation around a high altitude wetland

Tso-moriri, a typical brackish water lake is the second largest lake (perimeter 69.5 km or 143 km²) in Changthang region of Ladakh. This lake also receives three major freshwater streams from the surrounding catchment. The major strata sampled for vegetation composition around this lake were: (a) along the shoreline up to 10 m, (b) along the margins of freshwater streams, and (c) elevated areas >150 m from the bank.

The courses of freshwater streams near the junction of the lake were dominated by *Pedicularis tubiflora*, *Ranunculus aquatilis*, *Juncus bufonius*, and *Poa* spp. The vegetation along the shore (away from fresh water) was dominated by *Carex melanantha*, *C. nivalis*, *Tanacetum tibeticum* and *Agrostis* sp. However, away from the shore *Oxytropis microphylla*, *O. lapponica* and *Draba altaica* were the most abundant species, while *Agropyron longiaristatus*, *Stipa sibirica* and *Stipa orientalis* were the common grasses. *Eurotia ceratoides*, *Caragana gerardiana*, *Potentilla fruticosa* and *Artemisea salsoloides* and *A. tanacetifolia* were the main shrub species on the slopes of Tsomoriri lake. The vegetation characteristics of this area are given in Table 4.

Table 4. Phytosociological data along shore, away from the shore and on islands at and around Tso moriri wetlands

Distance	Species richness (number)		Density (individuals m ⁻²)	Diversity	Evenness
	Shrub	Herb	Herb		
Islands (n=4)	-	11	64.5-194.3	0.110-1.260	0.100-0.573
5-10m (n=9)	4	33	19.1-665.0	0.319-1.642	0.164-0.840
150-200m (n=9)	4	29	7.1-311.9	0.358-2.140	0.258-0.883

3.5 Conclusions

- ♦ The mixed scrub (MS), a characteristic feature of steppe community, was the most dominant physiognomic type in all the sectors, except Rohtang (Greater Himalaya) and Changthang plateau. It may be noted that the Changthang plateau was dominated by sedge meadows followed by grasslands.
- ♦ The Zaskar region had highest percent cover of herbs at and around Kenlung and Patsio. Grass cover was highest between Kenlung and Nakeela, sedge cover at Pang and Patsio, and lichen cover between Suraj tal and Baralacha la areas. In Nubra valley, the percent cover of grasses was highest at and around Khalsar. Lichen cover was highest in between Khalsar and Khardung, while herb and shrub percentages were uniform throughout the region.
- ♦ Among the high passes Rohtang had the highest density and diversity of herbs. These passes show decrease in density, richness and diversity of herbaceous plants with the increase in altitude.

- ◆ Relict patches of riverine vegetation, patches of *Juniperus macropoda*, *Ephedra gerardiana*, *Capparis wightiana* and vegetation along the shores of high altitude lakes will need attention in terms of conservation and long-term monitoring.
- ◆ Further studies on the effects of soil chemistry, micro-topography and nutrient availability would be essential to understand the species distribution and vegetation dynamics around the lake.
- ◆ Impacts of livestock grazing would be addressed in detail during summer of 2001.

References

- Austin, C. & Heylingers, M.P. (1989).** Vegetation Survey Design for Conservation: Gradsect sampling of forests in North-eastern New South Wales. *Biological Conservation* 50: 13 – 32.
- Bonham, C.D. (1989).** Measurements for terrestrial vegetation. John Wiley & Sons.
- Gillison, A.N. & Brewer, K.R.W. (1985).** The use of gradient Directed Transects or Gradsects in Natural Resource Surveys. *Jour. Env. Manage.* 20:103-127.
- Kachroo, P., Sapru, B.L. & Dhar, U. (1977).** Flora of Ladakh: An ecological and taxonomic appraisal. Dehra Dun.
- Mani, M.S. (1978).** Ecology and phytogeography of high altitude plants of the north-west Himalaya, Oxford & IBH Publ. Co., New Delhi.
- Mueller-Dombois, D. & Ellenberg, H. (1974).** Aims and Methods of Vegetation Ecology. John Wiley & Sons.
- Osmaston, A.E. (1922).** Description of formations, *Ecology* 10: 135-39.
- Puri, G.S., Gupta, R.K., Meher-Homji, V.M. & Puri, S. (1989).** Forest Ecology: vol. 2: Plant form, Diversity, Communities, and Succession. Oxford & IBH Publ. Co. New Delhi.
- Rau, M.A. (1975).** High Altitude Flowering Plants of North West Himalaya. *Bot. Surv. of India*, Howrah.
- Rodgers, W.A. & Panwar, H.S. (1988).** Planning a Protected Area Network for India. Wildlife Institute of India, Dehra Dun Vols. I & II.
- Schweinfurth, U. (1957).** Die horizontale und vertikale vertretung der vegetaion in Himalaya. Bonn.
- Schweinfurth, U. (1984).** The Himalaya: Complexity of a mountain system manifested by its vegetation. *Mountain Research & Dev.* 4(4): 339-344.
- Shannon, C.E. and Wiener (1963).** The mathematical theory of communication. Univeristy of Illionois Press, Urbana, Illinois, USA.
- Simpson, E.H. (1949).** Measurement of diversity. *Nature* 163:688.

Acknowledgements

We are thankful to Mr. P.K. Joshi (IIRS, Dehradun), Gurmed, Jagdish (WII) and Chain Singh for their assistance during the field survey. We are also thankful to Mr. Rathore, (DFO, Keylong), Mr. Zargar (WLWarden, Leh), Angchuk and Rauf Ali (J & K Wildlife Department) and Hav. Naseem Khan (102 Engineers) for their help.

A Study of Traditional Health Care & Medicinal Plants

by C.P. Kala

4.1 Introduction

Ladakh, situated in the Indian Trans-Himalaya, is known by many names such as Muryul, Moonland, Broken Moon, The Land of Gompas, Indian Tibet, The Little Tibet and The Last Shangrila. All these names indicate the poor accessibility of Ladakh in the past and therefore for the long period of time it was relatively isolated and politically closed off. The local health care system along with the philosophy, metaphysics, arts, and culture developed in isolation in this part of Trans-Himalaya. Due to poor communication and remoteness not much is known to the rest of the world about the traditional medicine of Ladakh that is also known as 'Tibetan Medical System (TMS)' or 'Amchi Medical System' (Namgyal and Phuntsog 1990). In due course, Ayurveda influenced the TMS (Das 1976). After the advent of Buddhism in Ladakh during 2nd Century A.D. (Jina 1996) and thereafter many Ayurvedic works along with religious scriptures were translated into the Tibetan languages under the patronage of local kings and priests that created a revolution in the Tibetan medical knowledge (Das 1994).

Monasteries later on played an important role in the development of Tibetan Medical System through establishing Lord Buddha as a 'Medicine Buddha' (*Bhaishjya guru or vaiduryaprabha*). The significance of the Medicine Buddha as the 'Supreme Healer' in TMS for liberating the individual from suffering is an exemplary metaphor for the mystical elements, which are universally inherent in this healing tradition. The traditional healers, locally called amchis, focus their attention on spiritual factors even in the treatment of the simplest illnesses. Every amchi vows to regard medicine as an offering to the Medicine Buddha and all other medicine deities and considers his medical instruments as holy objects.

Like Ayurvedic system TMS is also founded on *tri-dosa* (three-maleficent) concept that the entire physical, physiological and metabolic activities are operated by three hormonal systems i.e. wind (*Vata; Lung*), bile (*Pitta; Khris pa*) and phlegm (*Kapha; Batkan*). Their harmonious state is responsible for perfect health and the little disturbance of this balance produces pathological state in the body (Namgyal and Phuntsog 1990). In TMS, understanding one's emotions, pulse readings and urine examinations are the essential tools to diagnose the diseases. Pulse readings and urine examinations are well described in TMS but such descriptions are absent in earlier Ayurvedic classics (Das 1976).

The ingredients of Tibetan medicine are derived from plants, minerals and animal products. Plant products are used in highest proportion of which many species are of rare and endangered categories. These rare plants are the valuable ingredients for some medicines and large quantities are used in preparing some of the medicines. The population of these rare plants is extremely low in the present study area, Ladakh, and therefore these species are either collected from outside Ladakh or purchased from the wholesalers. Most of the rare and endangered animals of Ladakh region are also used as ingredient in Tibetan medicine of which many are Schedule I species of the Indian Wildlife (Protection) Act, 1972.

Natural resources in Ladakh are scarce and hard to obtain, yet Norberg-Hodge (1999) pointed out that before 1975 Ladakhis had a remarkable high standard of living with beautiful arts, architecture and jewellery. Most Ladakhis only really worked for 4 months of the year, and poverty, pollution and unemployment were alien concepts. During that period virtually all basic needs- food, clothing and shelter were provided without money. Labor was free of charge, part of an intricate and long established web of human relationship. In recent years, external forces and contacts with the modern world have debilitated and demoralized a once proud and self-sufficient people who today are suffering from what can best be described as a cultural inferiority complex. Now tourism constitutes bulk of the development in Ladakh. In this way people are becoming dependent on forces beyond their control- huge transportation networks, oil prices and the fluctuations of international finances. Therefore suddenly Ladakhis started feeling poor looking at outsiders coming in spending what was to them vast amount of cash on luxuries. Not realizing that money was essential in the west- that without it, people often go homeless or even starve (Norberg-Hodge 1999).

Due to rapid socio-economic changes at present in Ladakh the intention of local people is towards earning more money to meet their aspirations. Most of them do not have resources and vision to cope up with the changed scenario. Moreover, lack of opportunities for employment, better education and proper rural development schemes have forced the local people towards over-exploitation of surrounding natural resources leading to severe environmental problems. In the meantime, the traditional values, ethno-biological knowledge and respect for nature and natural resources are being neglected, which needs to be protected from degradation. Traditionally, only local people including amchis used these plant and animal species for own their consumption. But at present due to population explosion, establishment and needs of numerous pharmaceutical companies and money minded market forces are leading the severe crisis in resource management. As per one estimate there are some 50,000 pharmaceutical companies in India and the raw materials use in preparing medicine in these companies are gathered mostly from wild resources. Therefore there is a tremendous pressure on these wild medicinal plants and till now many of them either have become rare and endangered or they are struggling for their survival. Considering these facts a study was conducted with the objectives to document information on the traditional use of medicinal plants and animals in Amchi Medical System. Attempts were made to find out the best localities of medicinal plants within Ladakh especially of rare and endangered categories so that priority can be set up for the potential medicinal plants conservation areas.

4.2 Study area

Ladakh, falls in Indian Trans-Himalaya, lying to the north and in the rain shadow of the main Himalayan massif between $32^{\circ}15'$ to 36° N and $75^{\circ}15'$ to $80^{\circ}15'$ E, is usually described as a high altitude cold desert. It spans over an area of 96,701 sq. km (Om 1998), and is bounded by the eastern part of the Karakoram Mountains on the north and western extreme of the main Himalaya on the south. The altitude, in general, ranges from c. 3000 m (lower Indus and Nubra valleys) to 7680 m (Saser Kangri). The monotonously barren mountain landscape is broken by a host of small to large rivers, notably the Indus (which runs through Ladakh from south-east to north-west) and its tributaries like Zaskar, Markha, Shyok, Nubra, and Suru (cutting across in north-south or south-north directions meeting the mid-rib of Indus). Ladakh is extremely cold during winter when temperature goes down at places to minus 30 to 40°C . Annual precipitation decreases to the north and east, ranging from 500-1,000 mm in valleys just north of the main Himalaya to approximately 100 mm in the central Trans-Himalayan valleys such as the upper Indus near Leh (Fox *et al.* 1994).

The vegetation of Ladakh is dry alpine steppe and depicts typical high altitude desert characteristics that are composed of many unique and endemic plant species. A total of 611 plant species have been reported from different parts of Ladakh, of which 540 are dicots, 65 monocots and 2 are gymnosperms (Kachroo *et al.* 1977). Annual and perennial herbs followed by few dwarf shrubs dominate the flora of Ladakh. Vegetative growth starts with the onset of summer with melting of snow that provides abundant moisture to the plants to run their full course of development. The mountain slopes, alpine meadows, moraines and pasturelands give a spectacular display of varieties of flowers during July and August. The remarkable feature of Ladakh is a continuous and successive change in the floristic pattern during its growth period. Plants like *Draba*, *Christolea*, and *Arabis* are the first to bloom followed by species of *Corydalis*, *Primula*, *Saxifraga* etc. *Saussurea*, *Anaphalis*, *Leontopodium*, *Jurinea*, and *Waldheimia* blooms during the late summer (Aug-Sep).

In the different zones of Ladakh, vegetation changes gradually from primarily alpine meadow (*Carex*, *Potentilla*, *Nepeta*) on the north side of the Himalayan crest to steppe vegetation (*Caragana*, *Artemisia*, *Stachys*, *Ephedra*, *Stipa*) towards the north and east, with shrublands (*Hippophae*, *Salix*, *Myricaria*) along the river courses (Kachroo *et al.*, 1977). The region is virtually treeless, except for poplar and willow species planted along the major river courses. *Hippophae*, a rare medicinal plant is the dominant shrub along the Indus, Shyok and Nubra river valleys followed by *Myricaria*. Apparently juniper and birch have disappeared from many areas within historical times and only a few relict stands still survive in some of the more remote river gorges (Fox *et al.*, 1994). There are many large brackish water lakes, which form breeding grounds of number of endangered migratory birds such as black-necked crane and bar headed geese. Though Ladakh boasts of a distinct assemblage of high altitude flora and fauna, it still remains the least protected ecosystem with only one national park, viz., Hemis NP covering Rumbak and Markha valleys. To protect the biodiversity of Ladakh,

three protected areas viz., Hemis National Park (4100 km²), Karakoram Wildlife Sanctuary (5000 km²) and Changthang Wildlife Sanctuary (4000 km²), have been notified so far. There are also five wildlife reserves (Randum, Sabu-Chakur, Rizong Basgo, Gya-Miru and Kangri) and three game reserves (Boodh Karbu, Tongri and Lung lang) in Ladakh (Rodgers *et al.* 1998).

Administratively, Ladakh is divided into two districts, Leh and Kargil. The people of eastern Ladakh (Leh) are predominantly Buddhist while people of western Ladakh (Kargil) have a high proportion of Muslims. Buddhists speak Tibetan dialects while Dard dialect prevails in Muslims dominated areas of Drass and Kargil. Ladakhis have their own social customs similar to the Tibetans right from childbirth to death. In Buddhist dominated areas for the treatment of diseases TMS prevails whereas local doctors (Hakims) in the Muslim dominated areas such as Drass, Kargil, Sankhoo, and Mulbek practise Unani system. A large section of Buddhists still depend on the amchi medicine due to remoteness of their settlements, high prices of allopathic medicine and unavailability of modern medical facilities.

4.3 Methods

4.3.1 Survey of medicinal plants

TMS, adopted by Amchis who resided in different valleys of Ladakh, was studied. The field survey was conducted in Nubra, Kargil, Drass, Changthang, Hemis, and Leh valleys of Ladakh during the snow free period (July-August) in 2000 of the approximately 125 amchis living in different valleys of Ladakh, 43 were available for interview. Unstructured and semi-structured questionnaire surveys were conducted and information was collected on the medicinal plants in use, plant parts used, medical name of plants, trade in medicinal plants and areas of their collection. Besides, information was collected on use of mineral and animal parts. Field visits were made with amchis for identification and verification of plant species in use. A list of medicinal, rare and endangered plant species was prepared based on interviews with amchis, field visits, and existing literature.

4.3.2 Assessment of traditional knowledge among Amchis

To assess the traditional knowledge on medicinal plants among various age groups of amchis, they were categorised into 4 age classes i.e. <25 (new generation or students of Tibetan medicine), 25-35 (young practitioners), 35-45 (adults) and >46 (old or veterans). Information was also gathered on the number of students an amchi teaches for collecting information on the transfer of amchi knowledge through generation. Attitudes of the next generation towards learning of this traditional knowledge were analysed using the semi-structured interviews.

4.4 Results and Discussion

4.4.1 History and Evolution of TMS

In India, the history of medicinal plants can be traced back to the Vedic period (4500 BC to 1500 BC). The identity of several plants is referred to in the Rig-Veda. Atharveda contains detailed information on approximately 2,000 medicinal plants and their uses. The works of Charak (Charak Samhita) and Susruta (Susruta Samhita) deal with 700 drugs of daily and specific uses. The period of 16th and 17th century witnessed a spurt in the development of medical botany and most of the world famous medical drugs came into light during this period. Therefore, this period is called as 'The Age of Herbal Medicines'.

The earlier inhabitants of Tibet and Ladakh probably practiced shamanism, which was prevalent in whole of the northern Asia by the name of 'Bön' (Das 1976). There is evidence that several important forms of medical practice existed in this part of Trans-Himalaya during the pre-Buddhist era since the 7th century till the present day. King Strongsten Gampo, the founder of Lhasa city, is known to have introduced Buddhism into Tibet in AD 639 whereas in Ladakh Buddhism was introduced much earlier during 2nd Century AD (Jina 1996). King Strongsten Gampo was also responsible for the written Tibetan alphabet, which was adapted from the Sanskrit Devanagari characters. Along with the sermons of Lord Buddha, 'Bauddha Bhiksus' of India introduced the knowledge of Ayurveda and propagated it among their disciples in Ladakh and Tibet. Later on, the Buddha was established as the medicine Buddha (Men-la). Besides India, China, Mongolia, Persia, Ladakh and Nepal contributed in the evolution of Tibetan medicine. The science of 'Ser-khab' or golden needle healing originated only in Tibet (Dommer 1988). A tradition of Buddhist medicine continued to flourish through Kumaraviva, Acharya Nagarjuna, Ashva Gosh, and Chandranandan. In the 8th century A.D., a galaxy of Indian and Tibetan scholars was engaged in translation of Buddhist texts from Sanskrit into Tibetan. In order to popularize these difficult texts in Tibet, the senior Yuthog of Tibet wrote comprehensive commentaries on these ancient texts (Namgyal and Phuntsog 1990).

About 900 years ago, during the reign of king Lhablama Ye-shes-od, the learning of Buddhist medicine was introduced in the province of Kuge and neighboring areas in the western Himalayas. In that period the Mtho-gling monastery played an important role in translating the later Buddhist medical texts from Sanskrit into Tibetan under the supervision of great translator Rinchen Bzanpo (Namgyal and Phuntsog 1990). The 5th Dalai Lama (1617-1687) established the first school of Tibetan medicine at Garden Monastery in Lhasa. Later a medical collage and hospital was built near Lhasa at Chagpori. In 1916, the 13th Dalai Lama established a new college of Astrology and Medicine at Lhasa. In 1961, the 14th Dalai Lama in exile established the Men-Tsee-Khang (Tibetan Medical and Astrology Institute - TMAI) at Dharamsala in Northern India. Approximately half of the students in this organization are women. The Chogpori Tibetan Medical Center established by Lama Trogawa Rinpoche in Darjeeling, India

has strong links with the monastic tradition of education and only men are accepted as students. In 1989, Ladakh School of Tibetan Medicine was established in Leh that is affiliated to the Tibetan Medical and Astrology Institute, Dharamsala. The Tibetan Medical School, Central Institute of Higher Tibetan Studies, in Sarnath, Varanasi, India also runs a seven-year recognized course. Besides the Tibetan Medical Course, Sanskrit and the Tibetan language are taught at graduate level to facilitate research work at the institute.

4.4.2 Medicine Buddha

There are many incarnation of Buddha such as Buddha Maitreya (*Sangye Jampa*), Buddha Dipamkar (*Sangya marmey zey*), Buddha Amitabha (*sang gyy voe pak mey*) Buddha Sakyamuni (*sang gye shakya thubpa*), etc. those directly appear on earth as human beings. Whereas some Buddha emanations may be in the form of a statue, or speech, mind, attributes and activities, for instance, the Tibetan Medicine Buddha. The original teachings of ancient TMS are generally attributed to the Buddha who is said to have taught the root of the tradition in the manifestation of the Medicine Buddha.

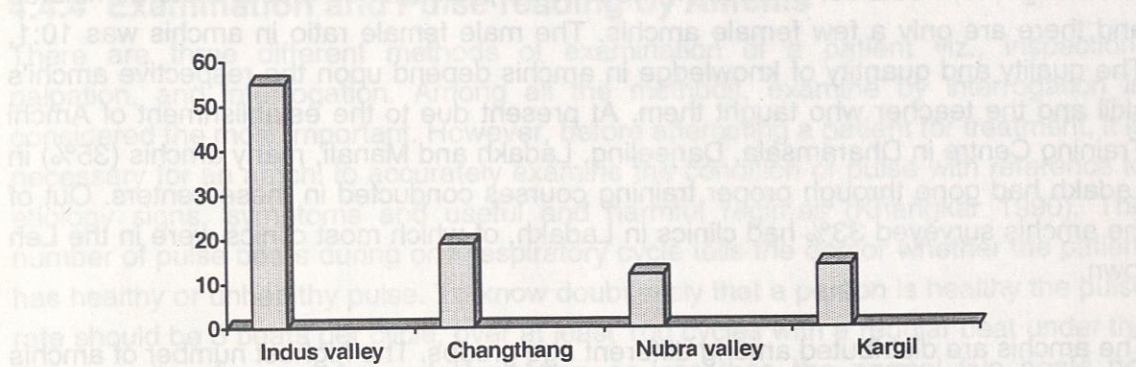
The right hand of Medicine Buddha holds an arura (*Terminalia chebula*) and left hand holds a begging bowl. His right hand is extended, palm outward, over his right knee in the gesture called supreme generosity. Arura is considered the best medicine in TMS. The position of his right hand and the arura, which he holds, represent the eradication of suffering, especially the suffering of sickness, using the means of relative truth. The name of the Medicine Buddha is believed to have the power to free one from the pattern of negative thoughts and emotions. Just by speaking, hearing or concentrating on His name healing can be accomplished. Apart from this, Tibetan Buddhist tools for awakening also promote healing and relaxation. In traditional Tibetan culture, practicing meditation and working (or playing) with prayer wheels, incense, chants, and prayer flags all are used together with Tibetan medicine. Amchi focuses his attention on spiritual factors even in the treatment of the simplest illnesses. Every amchi vows to 'regard medicine as an offering to the Medicine Buddha and all other medicine deities' and considers his 'medical instruments as holy objects'. Even in the Tibetan pharmaceuticals the medicines, which are mixtures of vegetable, animal and mineral compounds, are prepared with meticulous attention to religious ritual.

4.4.3 Profile of Amchis in Ladakh

Amchis enjoy high respect and social status in the Ladakhi society. The meaning of amchi is itself explanatory in Ladakhi that means 'superior of all'. They do not merely follow the theoretical texts but also have practical knowledge, which is handed over to them from generation to generation. Traditionally amchis were farmers with a secondary occupation as amchi. They offered their services and in exchange one member of every household in his practice helped him during the planting and harvesting period. But with the introduction of money economy amchis had to earn for their survival so they started selling the medicine or even the medicinal plants.

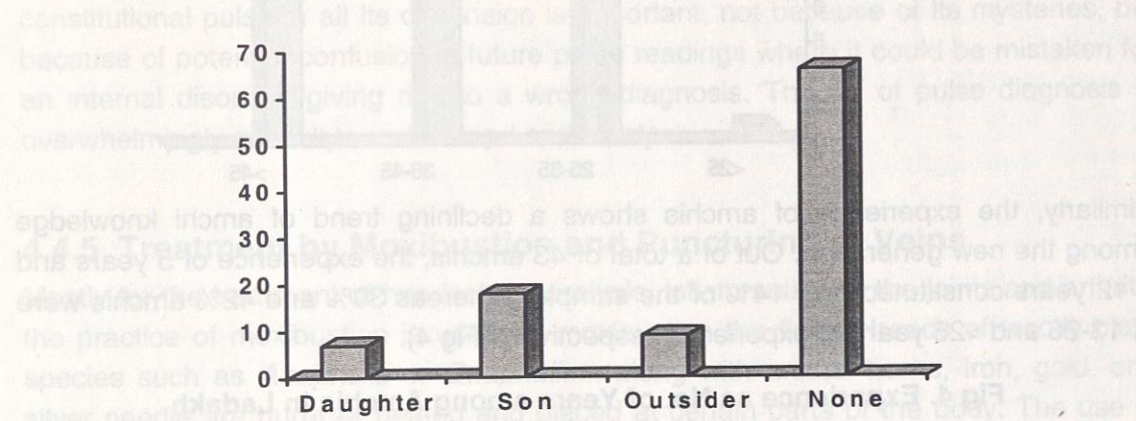
Amchis in Ladakh are looking after 60% of public health. Of almost 125 amchis of Ladakh, 43 (35%) were interviewed. The highest number of amchis (55%) were found along the Indus Valley, which is the most populated area within Ladakh. Many amchis from side valleys come to practice in Leh especially during the summer season. Out of 43 amchis interviewed, 24 (55%) were from Indus valley, 8 (19%) from Changthang plateau, 5 (12%) from Nubra valley and 6 (14%) were from Kargil district (**Fig 1**).

Fig 1. Distribution of amchis in different valleys of Ladakh



All the amchis willing to continue the tradition have earnest desire to teach anyone whosoever like to learn this tradition. Unfortunately, this tradition is not much popular in the younger generation. They go to amchis for treatment but are hardly willing to adopt the tradition professionally. Inspite of willingness of amchis to transfer the knowledge to younger generation most of the amchis (66%) do not have any disciple or student that indicates that amchi system of medicine in Ladakh is declining rapidly. Only 18% of the total amchis were able to teach their son, 7% to the daughter, and 9% to an outsider (Fig 2).

Fig 2: Transfer of amchi knowledge through generation



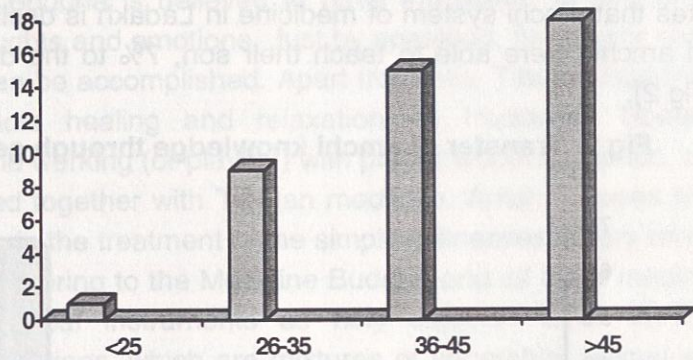
In Ladakh unlike its adjacent district Lahul-Spiti, the Amchi System of Medicine is well organized. In different valleys and regions amchis have their own committees that help them in sharing of medicinal plants, medical knowledge and medicine. The amchis of Changthang plateau have an association based at Nyoma. Almost all amchis of this region meet together at Nyoma every year during 1st to 15th September and share their opinion and raw material (medicinal plants and other products). Apart from this, the state Govt. has an amchi association, State Govt. Amchi Sabha, which is presided by

a Chief Amchi, Dr. Tsiring Phuntsog. All the amchis of Ladakh are members of this association. About 40 amchis at a given time are given some medicine, Rs. 300 per month and Rs. 1500 per annum as a subsidy for purchasing and preparing medicine. There are two more NGOs in district headquarter Leh working for the welfare of amchis.

Mostly being an amchi is a family tradition in Ladakh as it was a family tradition of 84% amchis, notwithstanding there were few amchis (16%) who learned this traditional knowledge from outside. In Ladakh, the amchi's profession is mostly male dominated and there are only a few female amchis. The male female ratio in amchis was 10:1. The quality and quantity of knowledge in amchis depend upon the respective amchi's skill and the teacher who taught them. At present due to the establishment of Amchi Training Centre in Dharamsala, Darjeeling, Ladakh and Manali, many amchis (35%) in Ladakh had gone through proper training courses conducted in these centers. Out of the amchis surveyed 33% had clinics in Ladakh, of which most clinics were in the Leh town.

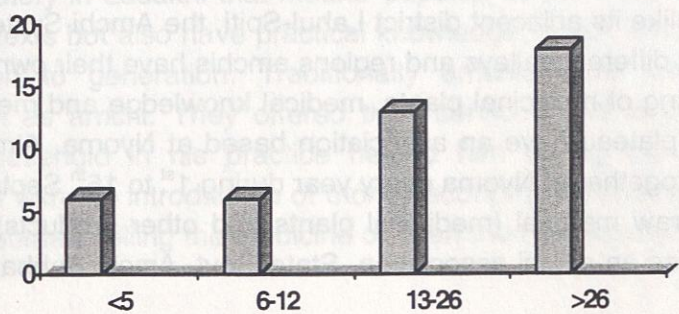
The amchis are distributed among different age groups. The highest number of amchis (42%) were more than 45 years old, 35% were adult (36-45 age group) and only 22% were below 35 years age (Fig 3). These age groups also indicate that amchi traditional knowledge is mainly restricted to the old generation and it is declining in younger generation.

Fig. 3. Age profile among amchis of Ladakh



Similarly, the experience of amchis shows a declining trend of amchi knowledge among the new generation. Out of a total of 43 amchis, the experience of 5 years and 6-12 years constituted only 14% of the sample. Whereas 30% and 42% amchis were of 13-26 and >26 years of experience respectively (Fig 4).

Fig 4. Experience as No. of Years among Amchis in Ladakh



Only 4% of the total amchis admitted that there is trade in medicinal plants but they did not disclose the trader's name. About 40% amchis admitted that they share the raw material (medicinal plants, animal parts, minerals, and stones) with the other amchis of adjacent valleys. There was consensus among all amchis on the question of use of plants but 2% expressed their ignorance on the use of minerals and 18% on the use of animal parts. The money spent in purchasing the raw material varies greatly among amchis from Rs. 1,000-60,000 annually.

4.4.4 Examination and Pulse reading by Amchis

There are three different methods of examination of a patient viz., inspection, palpation, and interrogation. Among all the methods, examine by interrogation is considered the most important. However, before attempting a patient for treatment, it is necessary for an amchi to accurately examine the condition of pulse with reference to etiology signs, symptoms and useful and harmful regimes (Khangkar 1990). The number of pulse beats during one respiratory cycle tells the doctor whether the patient has healthy or unhealthy pulse. To know doubtlessly that a person is healthy the pulse rate should be 5 beats per cycle, over at least 100 cycles with a regular beat under the three reading fingers of the doctor. More or less than the normal five beats per respiratory cycle indicates disorders (Khangkar 1985). Any irregular beat of the pulse whether strong, declining, quick, slow, violent or weak indicates that the pulse is unhealthy. Khangkar (1985) pointed out that when a being is born he or she born with three natural emotions, of ignorance, or passion, aggression and desire with one of these emotions dominating and bringing about in each individual a different temperamental and constitutional composition. Therefore even unhealthy persons or organisms, the beat and movement of the pulse may differ.

Few amchis believe that for the Tibetan doctors a clear understanding of the constitutional pulse in all its dimension is important, not because of its mysteries, but because of potential confusion in future pulse readings where it could be mistaken for an internal disorder, giving rise to a wrong diagnosis. The art of pulse diagnosis is overwhelmingly difficult to understand and master.

4.4.5 Treatment by Moxibustion and Puncturing of Veins

Mostly for the treatment of headache, paralysis, inflammation of the joints and arthritis the practice of moxibustion is used. In moxibustion the flower heads of woolly plant species such as *Anaphalis* or *Gnaphalium* along with animal horns, iron, gold, and silver needle are burnt or heated and placed at certain parts of the body. The use of materials depends on the seriousness of the diseases. Amchi allow the blood to ooze out for certain time by puncturing of veins through needles. Usually this therapy is employed for blood and skin disorders.

4.4.6 Use of Plants

The Lord Buddha taught that there is not a single ingredient on the earth, which does not have some form of therapeutic property. But to determine the proper use of ingredient is difficult (Khangkar, 1985). Plants have always been used for a wide range of necessities of human life. The wild plants are the major ingredients in Tibetan medicine. Each plant possesses intrinsic potency. Some plants are toxic and poisonous. They are purified prior to use by special detoxification and purification methods. Out of about 2000 drugs that have been used extensively in India, only 200 are of animal and mineral origins while the rest are of plant origin (Sharma and Mir 2000). According to WHO report, over 3/4th of the world total population can not afford the products of modern medicines and have to rely upon the use of traditional medicines of plant origin.

Plant are the prime source for preparing medicine in TMS. The use of plants by amchis of Lahaul-Spiti and Ladakh region of Trans-Himalaya has studied and documented by few researchers viz., Aswal and Mehrotra (1985, 1994), Chaurasia and Singh (1996), Balodi and Singh (1997), Manjrekar (1998), Kala and Manjrekar (1999), Chaurasia *et al.* (1999), and Kala (2000). Notwithstanding, so far no comprehensive list of medicinal plants has been prepared. There are some books in Buddhist in which the local names of medicinal plants are mentioned that needs to be translated into botanical names. During present survey a total of 285 medicinal plant species found in Ladakh were documented (**Table 1**), of which 46 are placed in different threat categories as per the Red Data Book of Indian Plants, CAMP workshops and other existing literature (**Table 2**).

Different parts of plants such as flowers, fruits, roots, tubers, bark, stems, and leaves are used in preparing medicine (Fig 5). The analysis of medicinal plants found in Ladakh and used by amchis indicate that majority of medicinal plant leaves (76 species) are used followed by flowers (60 species), shoot (60 species), roots (57 species), seeds (18 species) and fruits (13 species). The medicine that is given to the patients is very rarely made up of a single constituent. It is most often a combination of between 3-40 ingredients. The end product is either in the form of powder (chema), tablets (rilvo), paste (degu), ointment (chukma) or decoction (thang). All except the ointment are taken orally. At present, most of the trained amchi give the medicine in mainly pills form that are made in pharmaceutical companies or by some professional Tibetan drug manufacturers. Tibetan medicines are plant based and some of the medicines are only made up of plant and its parts, for instance A-gar 8, A-phyang and A-ru 7 (Tsarong 1986). Three examples of purely plants based medicine are given here in next page. The numerical value given at the end of the medicine name denotes the number of plants used in preparing the respective medicine, for example A-gar 8, A-gar 12, A-gar 15, A-gar 17, A-gar 19, A-gar 20, A-gar 31, A-gar 35 etc.

Table 1: Medicinal plant species found in Ladakh and used in Tibetan Medical System.
Abbreviations: Rt. -Root, Lf. -Leaf, Fl. -Flowers, Fr. -Fruits, Fl. Bud -Flowering Bud.

Species	Local name	Habitat type	Altitude (m)	Plant parts used	Uses	Locality	Flowering & Fruiting
<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Longze	Rocky slopes	4,650	Whole	Cardiac disorder	Leh valley	July-Aug
<i>Achillea millefolium</i> L.	Chuang	Plateau	3,600	Lf., Fl.	Tonic, cough, stomach pain	Changthang	July-Aug
<i>Aconitum balfourii</i> Stapf.	Bonga nakpo	Moist areas	3,700	Rt.	Sciatica	Zanskar	July-Aug
<i>Aconitum heterophyllum</i> Wall ex. Royle	Buma	Moist areas	3,800	Rt.	Tonic, diarrhoea, aphrodisiac	Zanskar	July-Sep
<i>Aconitum rotundifolium</i> Kar. & Kir.	Bonkar	Dry scrub	4,250	Rt.	Cough, blood purification	Zanskar	July-Aug
<i>Aconitum violaceum</i> Jac. Ex Stapf	Yangtso (Zinba)	Moist areas	2,880	Rt.	Cough	Nubra valley	June-Aug
<i>Actinocarya tibetica</i> Benth.		Undulating areas	3,540	Rt.	Fever	Leh, Nubra valley	July-Sep
<i>Adonis chrysocyathus</i> Hk. f. & T.	Semshi	Plateau, passes	5,250	Shoot	Skin diseases	Changthang	July-Aug
<i>Allium carolinianum</i> DC.	Gogcheegma	Scrubby slopes	4,000	Bulb, Lf.	Indigestion	Zanskar	July-Aug
<i>Allium humile</i> Kunth.	Pocha	Alpine pastures	4,000	Lf.	Heating effect	Zanskar	July-Aug
<i>Anaphalis contorta</i> (D. Don) Hk. f.	Telgang	Alpine slopes	4,650	Lf., Fl.	Cold & cough	Leh valley	July-Sep
<i>Anaphalis nepalensis</i> (Spreng.) Hand.-Mazz.	Tawa	Moraines	4,000	Lf., Fl.	Arthritis, fracture rib, synovitis	Leh, Nubra, Zanskar	June-Sep
<i>Anaphalis cuneifolia</i> Hk.f.	Simula	Rocky places	3,750	Shoot	Skin diseases	Nubra valley	July-Aug
<i>Anaphalis triplinervis</i> (Sims) Cl.	Phulu mentock	Rocky slopes	4,650	Lf.	Wounds	Leh, Changthang valley	July-Aug
<i>Androsace aizoon</i> Duly	Sgatik mugpo	Alpine pasture	4,000	Shoot	Indigestion	Zanskar	July-Aug
<i>Androsace mucronifolia</i> Watt.	Zigsolo	Alpine slopes	4,650	Shoot	Abdominal pain	Nubra valley	Aug-Sep
<i>Androsace rotundifolia</i> Hardw.	Zigsolo	Alpine pastures	4,200	Shoot	Stomachache	Zanskar, Nubra	July-Sep

Species	Local name	Habitat type	Altitude (m)	Plant parts used	Uses	Locality	Flowering & Fruiting
<i>Anemone rivularis</i> Buch.-Ham.	Zupka	Alpine pastures	4,300	Fr.	Gastritis, appetizer	Zanskar	July-Sep
<i>Anemone rupicola</i> Camb. Jacq.	Simaso	Moist areas	3,500	Shoot	Diuretic	Zanskar valley	June-Aug
<i>Aquilegia fragrans</i> Benth.	Zadul-dorje	Moist areas	4,200	Fl.	Headache	Zanskar	July-Aug
<i>Arabidopsis multiflorum</i> Hk. & T.	Imatso	Stony places	3,150	Lf.	Stimulate appetite	Nubra valley	July-Aug
<i>Arabis glandulosa</i> Kar. & Kir.	Umnako	Rocky places	3,750	Whole	Diarrhoea	Changthang, Nubra valley	June-Aug
<i>Arctium lappa</i> L.	Miah	Dry sandy areas	3,600	Rt.	Diuretic	Zanskar valley	June-Aug
<i>Arenaria bryophylla</i> Fern.	Lekhumi	Stony slopes	5,100	Shoot	Kidney disorder	Leh, Changthang valley	Aug-Sep
<i>Arenaria griffithii</i> Boiss.	Sokhtam	Stony slopes	3,300	Shoot	Menstrual cycle	Leh valley	July-Aug
<i>Arnebia euchroma</i> (Royle ex Benth) Johnston	Demok	Rocky slopes	4,950	Root	Hair tonic	Leh valley	July-Sep
<i>Artemisia biennis</i> Willd.	Khampa	Wastelands	3,700	Lf., Fl.	Antibiotic	Leh, Nubra, Hemis	July-Aug
<i>Artemisia brevifolia</i> Wall.	Khamchu	Stony slopes	4,650	Lf., Fl head	Fever	Leh, Nubra valley	July-Aug
<i>Artemisia desertorum</i> Spreng	Khamlöl	Wastelands	3,500	Lf.	Intestinal pain	Zanskar valley	June-Sep
<i>Artemisia dracunculus</i> Linn.	Burtse	Wastelands	3,153	Lf.	Toothache, menstrual cycle	Nubra valley	June-Aug
<i>Artemisia gmelinii</i> Weber ex Steckm	Khampa shridhi	Dry slopes	3,544	Lf	Cold & cough	Leh, Nubra valley	July-Sep
<i>Artemisia lacinata</i> Willd.	Bintso	Dry slopes	3,600	Lf.	Toothache	Zanskar valley	July-Sep
<i>Artemisia minor</i> Jacq. ex Bess.	Furnag	Dry slopes	3,800	Lf., Fl.	Indigestion, dermatitis, appetizer	Nubra	July-Aug
<i>Artemisia maritima</i> L.	Furnag	Dry slopes	4,000	Lf., Fl.	Indigestion, dermatitis, appetizer	Leh, Nubra, Hemis	July-Sep
<i>Artemisia moorcroftiana</i> Wall.	Phurnag	Wastelands	3,900	Lf., Fl.	Dermatitis	Zanskar	July-Sep
<i>Artemisia parviflora</i> Roxb.	Khamang	Plateau	4,450	Whole	Diuretic	Changthang	June-Aug
<i>Artemisia salsoloides</i> Willd.	Amango	Dry slopes	3,800	Shoot	Intestinal complaints	Zanskar valley	June-Aug
<i>Artemisia scoparia</i> Waldst. & Kit.	Khamtso	Dry slopes	3,900	Shoot	Intestinal worms	Changthang	July-Sep

Species	Local name	Habitat type	Altitude (m)	Plant parts used	Uses	Locality	Flowering & Fruiting
<i>Artemisia sieversiana</i> Willd.	Khamchu	Rocky slopes	2,850	Lf, Fl., Rt	Intestinal worms, bronchitis	Leh, Changthang valley	July-Sep
<i>Artemisia stracheyi</i> Hk. f. & T. ex Comp.	Rumonlo	Plateau	4,500	Shoot	Toothache	Changthang	June-Aug
<i>Astragalus rhizanthus</i> Royle ex Benth	Sarma	Stony slopes	3,550	Shoot	Skin diseases	Leh valley	July-Sep
<i>Aster diplostephiodes</i> (DC.) Cl.	Ba-sha-ka, Lugchung	Moist slopes	4,200	Lf.	Anemia, septicemia	Zaskar	July-Sep
<i>Aster flaccidus</i> Bunge.	Lugmig Chunwa (small)	Moist areas	4,500	Lf., Fl.	Pulmonary infections	Nubra	July-Sep
<i>Aster stracheyi</i> Hk. f.	Lugmig metura (large)	Rocky		Lf., Fl.	Pulmonary infections	Drass	July-Sep
<i>Astragalus strictus</i> Graham ex Benth	Serpang	Rocky slopes	4,650	Shoot	Diuretic	Leh, Changthang valley	July-Sep
<i>Astragalus tribulifolius</i> Benth.	Yanglo	Cultivated field	3,000	Whole	Diuretic, kidney complaints	Nubra valley	July-Aug
<i>Atelantha perpusilla</i> Hk. f. & T.		Sandy places	4,300	Lf.	Fever	Zaskar valley	July-Aug
<i>Berberis ulicina</i> Hk. f. & T.	Sherpa	Riverine areas	3,000	Rt., Bk., Fr.	Tonic	Nubra valley	June-Aug
<i>Berberis zabeliana</i> Schn.	Sherpa	Sandy areas	3,400	Rt.	Fever	Nubra valley	July-Sep
<i>Bergenia stracheyi</i> (Hk. f. & T.) Engl.	Dak-kyahawo, Gatikpa	Rocky	4,300	Rt., Fl.	Blisters	Zaskar	July-Sep
<i>Betula utilis</i> D. Don	Takpa	Rocky	3,650	Bk., Lf.	Jaundice, burns, wounds	Zaskar	June-July
<i>Biebersteinia odora</i> Stephan & Fischer	Khardung	Alpine slopes	4,650	Lf	Septic wounds	Leh, Nubra valley	July-Aug
<i>Bistorta affinis</i> (D. Don) Greene	Langna	Dry rocky	4,200	Fl.	Abdominal & back pain	Zaskar	July-Sep
<i>Bistorta vivipara</i> (L.) S.F. Gray	Naram, Langangpa	Moist slopes	4,600	Rt.	Diarrhoea	Nubra, Zaskar	July-Sep
<i>Blumea bifoliata</i> (DC.) Wight Contrib.	Leuman	Plateau	3,450	Rt.	Fever	Changthang	June-Aug

Species	Local name	Habitat type	Altitude (m)	Plant parts used	Uses	Locality	Flowering & Fruiting
<i>Bupleurum himalayense</i> Klutz.	Sah-kuchak	Alpine pastures	4,000	Rt., Lf.	Colic, Renal complaints, Gastrointestinal	Zaskar	July-Aug
<i>Bupleurum marginatum</i> Wall. ex DC.	Zira-shepo	Alpine pastures	3,800	Rt.	Gastrointestinal	Zaskar	July-Aug
<i>Capsella bursa-pastoris</i> (L.) Medik.	Zokka	Roadsides, agricultural field	3,700	Lf., Fl., St., Fr.	Fever	Nubra, Zaskar	June-Oct
<i>Caragana gerardiana</i> Royle ex Benth.	Zomosing	Gullies, dry slopes	4,600	Lf., Fl.	Arthritis, Vertigo	Hemis, Nubra Changthang	July-Sep
<i>Caragana versicolor</i> (Wall.) Benth.	Zonsing	Sandy slopes	4,400	Rt.	Dysmenorrhoea	Hemis, Nubra Changthang	July-Sep
<i>Carum bulbocastanum</i> Koch.	Gosnyod	Dry slopes	4,000	Seeds	Fever, dysentery	Leh, Nubra	July-Aug
<i>Carum carvi</i> L.	Gonyot	Dry slopes	3,600	Seeds	Nose pain	Leh, Nubra, Zaskar	July-Sep
<i>Centauria picris</i> Pall	Konpa gabskyes	Dry slopes	3,700	Fl.	Eczema	Leh, Nubra	July-Sep
<i>Cerastium cerastoides</i> (L.) Brith.	Spangian karmo, Pangien	Moist areas	3,800	Shoot	Bodyache, Backache, Headache	Nubra, Zaskar	July-Aug
<i>Chenopodium botrys</i> L.	Sanyek	Dry areas, cultivating fields	3,600	Lf., Fl.	Indigestion	Leh, Nubra, Kargil	July-Sep
<i>Chenopodium foliolosum</i> (Moench) Asch.	Sanyek	Sandy riverbeds	3,700	Lf., Fl.	Indigestion	Leh, Nubra	July-Sep
<i>Chenopodium hybridum</i> L.	Sanyek	Wastelands	3,600	Lf., Fl.	Indigestion	Leh, Kargil	July-Sep
<i>Christolea crassifolia</i> Camb.		Stony slopes	4,300	Shoot	Liver complaints	Nubra	July-Sep
<i>Chrysanthemum griffithii</i> Cl.	Serpan	Plateau	4,950	Fl.	Menstruation	Changthang	July-Aug
<i>Chrysanthemum pyrethroides</i> (Karelin & Kir) B. Fed.	Serpan (Bhurse-khampa), Jerjum	Rocky slopes	4,650	Fl.	Fever, arthritis, septic	Leh valley	July-Aug
<i>Chrysanthemum tibeticum</i> Hk. f. & T.	Phemantso	Rocky slopes	4,000	Shoot	Septic wounds	Zaskar valley	June-Aug

Species	Local name	Habitat type	Altitude (m)	Plant parts used	Uses	Locality	Flowering & Fruiting
<i>Cicer microphyllum</i> Benth.	Seri-jriboo	Wastelands, alpine slopes	4,000	Shoot, seeds	Jaundice	Leh, Changthang	July-Sep
<i>Circium arvense</i> (L.) Scop.	Soh-chlia	River valley	3,800	Rt.	Wounds	Hemis	July-Aug
<i>Circium wallichii</i> DC.	Kakar	River valley	3,510	Lf.	Stomach pain	Leh, Changthang valley	July-Sep
<i>Clematis orientalis</i> L.	Emong nakpo	Dry slopes	3,500	Fl., Lf.	Fever	Leh, Kargil, Nubra	July-Sep
<i>Clematis tibetina</i> Kuntze	Zakzic	Cultivated areas	2,850	Rt., St.	Itching	Leh valley	July-Sep
<i>Codonopsis clematidea</i> (Schrenk) Cl.	Ludut dorje	Marshy	3,650	Fl.	Skin disease, blisters	Zaskar	July-Aug
<i>Codonopsis rotundifolia</i> Benth.	Klupdud dorje	Marshy	3,800	Rt.	Skin disease	Zaskar	July-Aug
<i>Codonopsis ovata</i> Benth.		Marshy	3,800	Fl.	Skin disease	Zaskar	July-Aug
<i>Conringia planisiliqua</i> Fisch. & Mey.	Khaskar	Alpine slopes	4,600	Rt.	Diuretic	Zaskar valley	July-Sep
<i>Convolvulus arvensis</i> L.	Grachi	Dry slopes	3,700	Rt.	Purgative	Drass	July-Sep
<i>Corispermum hyssopifolium</i> L.	Seimso	Dry rocky	3,500	Rt.	Kidney disorder	Zaskar valley	June-Aug
<i>Corydalis govaniana</i> Wall.	Tongru-silva	Marshy	4,300	Fl., Lf.	Fever	Zaskar	July-Aug
<i>Corydalis meifolia</i> Wall.	Tonzil	Marshy	4,400	Shoot, Rt.	Leprosy, Headache, Stomachache	Zaskar	July-Aug
<i>Corydalis rutifolia</i> (Sm.) DC.	Chimlo	Roadsides	3,150	Shoot	Skin diseases	Nubra valley	June-Aug
<i>Corydalis tibetica</i> Hk. f. & Th.	Stong zil	Plateau	4,600	Whole	Fever	Changthang	July-Aug
<i>Cousinia thomsonii</i> Cass.	Chansar nagpo, Batsatsuak	Wastelands	3,800	Lf., Fl.	Fever, Arthritis	Leh, Nubra, Hemis	July-Sep
<i>Cremanthodium arnicoides</i> DC.	Rekonpa	Moist areas	5,400	Shoot	Fever, Diarrhea	Khurdungla	July-Aug
<i>Cremanthodium ellisii</i>	Dariya kan			Lf., Fl.	Fever		
<i>Crepis flexuosa</i> (DC.) Benth.	Remang	Stony places	3,150	Lf.	Muscle pain	Leh valley	June-Aug
<i>Crocus sativus</i> Linn.		Village areas	3,450	Fl. bud	Menstrual cycle	Leh valley	Aug-Sep
<i>Cuscuta approximata</i> Beib.	Amarlata	Wastelands	3,750	Shoot	Warts	Nubra valley	July-Aug
<i>Cuscuta capitata</i> Roxb.	Amarlata	Wastelands	3,700	Whole	Urinary disorder	Zaskar valley	June-Aug

Species	Local name	Habitat type	Altitude (m)	Plant parts used	Uses	Locality	Flowering & Fruiting
<i>Cuscuta europaea</i> Linn.	Amarlata	Village areas	3,150	Whole	Urinary, kidney & spleen complaints	Leh valley	July-Sep
<i>Cuscuta reflexa</i> Roxb.	Amarlata	Undulating areas	3,750	Whole	Warts	Leh, Changthang valley	Aug-Sep
<i>Dactyloctenium aegyptium</i> (L.) Don	Sanchu (Angbolakpa, wangluk)	Moist places	3,000	Tuber	Kidney complaints, aphrodisiac	Nubra valley	June-Aug
<i>Daphne genkwa</i> Sieb. & Zucc.							
<i>Delphinium elatum</i> L.	Lunde-kaown	Moist rocky slopes	4,950	Seeds	Insecticide	Changthang	July-Sep
<i>Delphinium cashmerianum</i> Royle	Lunde-kaown (Cha-gotpa)	Stony slopes	4,950	Seeds, Shoot, Fl.	Insecticide, colic, throat-ache	Leh valley	July-Sep
<i>Delphinium viscosum</i> Hk. f. Th.	Bilamonokh	Moist stony area	5,000	Fl., Rt.	Rheumatism, Oedema	Khardungla	July-Aug
<i>Descurainia sophia</i> (L.) Webb. ex Prantel	Teri-latchij	Alpine pastures	3,800	Seeds	Chicken pox	Drass	July-Sep
<i>Dianthus anatalicus</i> Boiss.		Alpine pastures	3,900	Lf.	Cough, Cold	Zaskar	July-Aug
<i>Dracocephalum heterophyllum</i> Benth.	Zinkzer, Driangu, Priyanku	Stony slopes	4,650	Fl., Lf., St.	Peptic ulcer, gastritis, hypertension, cough, headache	Leh valley	July-Sep
<i>Dracocephalum moldavicum</i> Linn.	Kirmir	Roadsides	4,800	Shoot	Intestinal worms	Changthang	July-Sep
<i>Dracocephalum staminatum</i> Kar. & Kir.	Ghiromanko	Slopes	3,150	Whole	Cough, headache	Changthang, Nubra valley	July-Sep
<i>Echinops cornigerus</i> DC.	Ekzema (Zanskar)	Village areas	3,400	Lf., Seeds, Fl. St.	Tonic, septic wounds, food poisoning	Leh valley	July-Sep
<i>Echinops niveus</i> Wall. ex DC.	Ekzema	Plateau	4,500	Shoot	Septic wounds	Changthang	July-Aug
<i>Ephedra gerardiana</i> Wall. ex Stapf.	Chhapat (Tse)	Stony slopes, gravelly soil	3,480	St.	Asthma, fever, bronchitis, rheumatism	Leh, Nubra valley	June-Sep
<i>Epilobium angustifolium</i> L.	Utpal-wanbo	Shady areas	4,000	Shoot	Abdominal pain, Renal complaints	Hemis, Nubra, Changthang	July-Sep
<i>Epipactis helleborine</i> (Linn.) Grantz.	Penginlo	Moist places	3,750	Shoot	Blood purification	Changthang	July-Aug

Species	Local name	Habitat type	Altitude (m)	Plant parts used	Uses	Locality	Flowering & Fruiting
<i>Eragrostis poaeoides</i> Beauv.	Gieng	Dry slopes	3,800	Rt.	Stomach complaints	Zanskar valley	July-Sep
<i>Erigeron alpinus</i> L.	Repan	Rocky	3,800	Whole	Cough & cold	Zanskar valley	July-Aug
<i>Eritricum canam</i> (Benth.) Kitamaru	Changser, tukse	Roadsides	3,750	St., Lf.	Child birth	Nubra, Hemis	July-Sep
<i>Ermanian lanuginosa</i> (Hk. f. & T.) O.E.S.	Measlo	Moist places	2,800	Lf.	Cuts, wounds	Nubra valley	July-Aug
<i>Erodium tibetanum</i> Edgew & Hk. f.		Alpine slopes	3,900	Shoot	Indigestion	Nubra	June-July
<i>Euphorbia stracheyi</i> Boiss.	Tingling	Sandy places	3,900	Latex	Boils	Leh valley	July-Sep
<i>Euphorbia tibetica</i> Boiss.	Tingling	Alpine pastures	4,200	Shoot	Nausea	Hemis	July-Aug
<i>Euphrasia laxa</i> Penn.	Kianglo	Sandy places	3,700	Whole	Eye complaints	Zanskar valley	July-Sep
<i>Ferula iaeschkeana</i> Vatke	Thunak, Risho	Dry slopes	3,600	Rt., Seeds	Chest pain	Drass	July-Sep
<i>Fritillaria roylei</i> Hook.	Chikmo	Alpine slopes	3,600	Bulbs	Asthma, tonic	Zanskar valley	July-Sep
<i>Galium pauciflorum</i> Bunge	Phomongo	Plateau	4,800	Shoot	Intestinal parasites	Changthang	July-Aug
<i>Galium serpillioides</i> Royle ex Hk. f.	Pemantso	Higher passes	2,880	Lf.	Kidney complaints	Nubra valley	July-Sep
<i>Gentiana algida</i> Pall.	Pungen carpow	Moist places	4,000	Lf., Fl.	Sore throat	Zanskar	July-Aug
<i>Gentiana carinata</i> Griseb.	Ziang	Moist places	4,650	Rt.	Stomach pain	Nubra valley	July-Aug
<i>Gentiana kurroo</i> Royle	Pangyin	Moist slopes	4,200	Fl.	Cough	Zanskar	July-Aug
<i>Gentiana nubigena</i> Edgew.	Pangyin	Moist slopes	5,000	Fl.	Cough	Khardungla	July-Aug
<i>Gentiana olivieri</i> Griseb.	Khilche Nagpo	Moist slopes	4,800	Shoot, Rt.	Fever	Zanskar	July-Aug
<i>Gentiana squarrosa</i> Ledeb.	Ziang	Alpine slopes	5,000	Rt.	Diuretic	Zanskar valley	July-Aug
<i>Gentiana stracheyi</i> (Cl.) Kitam.	Ziang	Moist places	5,000	Rt.	Tonic	Zanskar valley	July-Aug
<i>Gentianella moorcroftiana</i> (Wall. ex. G. Don) Airy Shaw	Teekta	Moist slopes	3,700	Lf., Fl.	Fever, headache, jaundice, acidity	Zanskar	July-Sep
<i>Gentianella paludosa</i> (Hk.) H. Smith	Pallutso	Moist slopes	3,600	Rt.	Tonic	Zanskar valley	July-Sep
<i>Gentianopsis defonsa</i> (Rottb.) Ma.	Shiti	Moist places	3,800	Fl.	Nausea, Cough, Fever, Headache	Zanskar	July-Aug
<i>Geranium pratense</i> Linn.	Gagchuk (Ngon-boo)	Stony slopes, wet places	4,650	Lf., Fl	Diarrhoea, headache	Leh valley	July-Aug

Species	Local name	Habitat type	Altitude (m)	Plant parts used	Uses	Locality	Flowering & Fruiting
<i>Geranium sibiricum</i> Linn.	Eyamlomentok	Sandy & wastelands	2,880	Lf.	Diarrhoea	Nubra valley	July-Sep
<i>Geranium tuberosum</i> Camb.	Yusiang	Rocky slopes	4,950	Shoot	Kidney stones	Changthang	June-Aug
<i>Gnaphalium affine</i> D. Don	Gandha pattra	Moist areas	3,800	Lf., Fl.	Hypertension, arthritis	Nubra, Zaskar	June-Sep
<i>Gnaphalium stewartii</i> Cl.	Peo	Sandy places	3,600	Whole	Skin diseases	Zaskar valley	June-Sep
<i>Halepistes tricuspidis</i> (Maxim.) Hand.-Mazz.		Rock-crevices, marshy area	3,483	Shoot	Toothache, eye inflammation	Leh valley	July-Aug
<i>Heracleum lanatum</i> Michx.	Tunak, tukar	Marshy	3,650	Fl., Lf.	Liver complaints, Arthritis	Drass	June-Sep
<i>Herminium monorchis</i> (L.) R. Br.		Moist places	3,070	Tuber	Kidney complaints	Nubra valley	June-Sep
<i>Hippophae rhamnoides</i> L.	Tar-ngoo, Starbu, Zing	Riverbeds	3,550	Fr.	Lung infection	Leh, Nubra	June-Oct
<i>Humulus lupulus</i> L.		Village area	3,450	Fl.	Tonic, improve appetite	Leh valley	July-Sep
<i>Hyoscyamus niger</i> L.	Thangdum, langtang-tse	Village site	3,580	Fr.	Toothache	Leh, Nubra, Hemis	July-Sep
<i>Hypericum leptocarpus</i> Hk. f. & T.	Meerang	Grazing ground	3,700	Lf.	Septic wounds	Zaskar valley	July-Sep
<i>Hyssopus officinale</i> L.	Jip-chi, chibu	Dry slopes	3,800	Lf.	Fever, stomachache	Zaskar	July-Sep
<i>Inula rhizocephala</i> Shrenk.	Riamko	Moist rocky places	4,650	Rt.	Cold, cough	Nubra valley	July-Sep
<i>Inula racemosa</i> Hk. f.	Manu	Cultivated		Rt., Fl	Gastrointestinal, Rheumatism		Aug-Sep
<i>Inula royleana</i> DC.	Ukchha			Rt.	Headache		Aug-Sep
<i>Iris ensata</i> Thunb.	Banpiaj	Dry areas	3,600	Fl., Seeds	Ringworm, sores	Leh, Kargil, Drass, Nubra	June-Sep
<i>Juglans regia</i> L.	Akhrot	Planted		Bark	Skin diseases, toothache		May-Oct
<i>Juniperus communis</i> L.	Shukpa	Dry slopes	4,500	Fr., Lf.	Kidney disorder	Drass, Kargil	June-Oct
<i>Juniperus recurva</i> D. Don	Shukpa	Dry slopes	4,500	Shoot	Kidney disorder	Drass, Zaskar	June-Oct
<i>Jurinea ceratocarpa</i> (Decne.) Benth.	Chholmong	Dry & sandy areas	3,540	Lf.	Asthma, wounds bronchitis,	Leh valley, Nubra	July-Sep

Species	Local name	Habitat type	Altitude (m)	Plant parts used	Uses	Locality	Flowering & Fruiting
<i>Koelpinia linearis</i> Pall.	Nodar	Alpine pasture	3,900	Shoot	Rheumatism	Drass	July-Aug
<i>Lactuca serriola</i> L.	Dudej	Alpine slopes	4,000	Shoot	Jaundice, Malaria	Leh, Nubra, Markha	July-Sep
<i>Lagotis kunawurensis</i> (Royle) Rupr. Mem.	Tsermo	Alpine pasture	4,900	Lf.	Cough & cold	Zaskar valley	July-Sep
<i>Lancea tibetica</i> Hk. f. Th.	Payak-tsa	Marshy	4,150	Seeds	Cough, blood vomiting	Zaskar	July-Aug
<i>Leontopodium nanum</i> (Hk. f.) Hand.	Palu	High passes	4,950	Whole	Septic wounds	Leh valley	July-Aug
<i>Lepidium latifolium</i> L.	Shangshu	Dry slopes	3,600	Shoot	Rheumatism	Leh, Changthang, Nubra, Hemis	July-Sep
<i>Leucopoa albida</i> (Turcz.) Kercz. & Bobr.	Fukche	Sandy areas	3,600	Whole	Intestinal complaints	Zaskar valley	June-Sep
<i>Lomatogonium rotatum</i> (L.) Fries ex Nym.	Tsemrang		3,900			Khardung, Nubra	July-Aug
<i>Lonicera spinosa</i> (Jac. ex Decne.) Walp.	Lamora	Rocky slopes	3,150	Fl.	Asthma, headache	Leh valley	July-Sep
<i>Lloydia serotina</i> (Linn.) Reichb.	Kangkar (Tsa-awa), Anwa	Alpine passes	3,880	Tuber, Lf.	Blood purification, fever, eye infection	Nubra valley	July-Sep
<i>Lupula barbata</i> (Bieb) Gurke		Wastelands	3,600	Rt.	Fever	Changthang	July-Sep
<i>Lychnis nutans</i> Benth.	Lappu	Moist places	3,500	Rt.	Dysentery	Zaskar valley	June-Sep
<i>Lycium ruthenicum</i> Muuray ex Dunal	Umila	Roadsides	3,090	Lf.	Diuretic	Nubra valley	July-Sep
<i>Malva verticillata</i> L.	Chiroti	Alpine pasture	3,800	Rt., Seeds	Piles, cough	Kargil, Drass	July-Aug
<i>Malva sylvestris</i> L.	Sotsal	Alpine pasture	3,600	Rt., Seeds	Kidney complaints	Kargil, Drass	July-Sep
<i>Marrubium vulgare</i> L.	Tropper	Dry areas		Shoot	Rheumatism, boils	Zaskar	July-Sep
<i>Mattiastrium thomsonii</i> (Cl.) I.M.J.		Slopes	4,650	Lf.	Intestinal worms	Nubra valley	June-Aug
<i>Meconopsis aculeata</i> Royle	Serhun, Tsergnon	Stony desert	4,000	Lf., Fl., Fr.	Fracture, Tonic	Zaskar	Aug-Sep
<i>Meconopsis horridula</i> Hk.	Udpal snogpo	Stony areas	4,100	Lf., Fr.	Backache, Colic	Zaskar	July-Sep
<i>Meconopsis simplicifolia</i>	Udpal snogpo	Stony areas	3,900	Lf., Fl.	Backache, Colic	Zaskar	Aug-Sep

Species	Local name	Habitat type	Altitude (m)	Plant parts used	Uses	Locality	Flowering & Fruiting
<i>Meconopsis sinuata</i>	Udpal snogpo	Stony areas	4,000	Lf., Fl. Fr.	Backache	Zaskar	July-Sep
<i>Medicago lupulina</i> L.	Gun yok	Dry areas	3,600	Shoot	Kidney disorder	Leh, Nubra, Kargil, Drass	July-Sep
<i>Melica persica</i> Kunth.	Tandi	Dry sandy slopes	3,700			Leh, Markha	July-Sep
<i>Mentha longifolia</i> (Linn.) Hudson	Phololing	Moist places	3,450	Lf.	Headache, stomach upset	Leh valley	July-Sep
<i>Morina coulteriana</i> Royle	Khundaj, Kare	River valley	3,600	Rt.	Eye complaints	Drass	July-Sep
<i>Morina longifolia</i> Wall. ex DC.	Biskandara	River valley	3,600	Rt.	Boils	Drass	July-Sep
<i>Myricaria rosea</i> W.W. Smith	Hombuk	River valley	3,600	Stem pith	Food poisoning	Leh, Nubra	May-June
<i>Myricaria squamosa</i> Desv.	Ombu	River valley	3,600	Stem pith	Food poisoning	Leh, Nubra, Hemis	July-Sep
<i>Nepeta cataria</i> L.	Gandhsoi	Dry slopes	3,700	Shoot	Dysentery	Leh, Kargil	July-Aug
<i>Nepeta coerulescens</i> Maxim.	Neimlo	Dry slopes	3,800	Lf.	Dysentery	Zaskar valley	June-Aug
<i>Nepeta discolor</i> Royle ex Benth.	Nyomalo	Rocky slopes	3,400	Lf.	Cough, cold	Nubra valley	July-Sep
<i>Nepeta erecta</i> (Benth.) Benth.	Eripantso	Sandy places	3,450	Shoot	Dysentery	Changthang	June-Aug
<i>Nepeta eriostachia</i> Benth.	Zimthik le	Dry slopes	3,600	Shoot	Eye complaints	Nubra, Zaskar	July-Sep
<i>Nepeta floccosa</i> Benth.	Shamalolo	Stony slopes	3,550	Lf.	Cold & cough, malaria	Leh & Zaskar valleys	July-Sep
<i>Nepeta glutinosa</i> Benth.	Gimanko	Stony slopes	3,300	Lf., Fl.	Diarrhoea	Nubra valley	July-Aug
<i>Nepeta leucolaena</i> Benth.	Beimtso	Dry slopes	3,500	Lf.	Skin disease	Zaskar valley	June-Aug
<i>Nepeta longibracteata</i> Benth.	Teyanku	Rocky places	4,350	Shoot	Liver disorder, stomachache, indigestion	Changthang	July-Aug
<i>Nepeta podostachys</i> Benth.	Shangukaram	Rocky slopes	4,650	Rt., St.	Kidney complaints	Leh, Changthang	July-Sep
<i>Origanum vulgare</i> L.	Lachung	Dry areas	3,900	Whole	Tonic, Cold, Hysteria, Fever	Zaskar	June-Sep
<i>Oxyria digyna</i> (L.) Hill	Chur-tse, chum tse	Sandy	4,300	Fl.	Diarrhoea	Leh, Nubra, Khardungla, Markha	July-Sep
<i>Oxytropis microphylla</i> (Passas) DC.	Stagscha Nagpo	Dry areas	4,400	Whole	Wounds	Changthang	July-Sep

Species	Local name	Habitat type	Altitude (m)	Plant parts used	Uses	Locality	Flowering & Fruiting
<i>Oxytropis microphylla</i> (Pallas) DC.	Taksha, rechakpa	Dry	3,700	Rt., Fl., Lf.	Septicemia, Joint pain	Changthang, Hemis	June-Aug
<i>Oxytropis tatarica</i> Bunge.	Sarkash	Dry areas	3,800	Shoot	Diuretic	Changthang	June-Aug
<i>Paraquilegia microphylla</i> (Royle) Drumm. Et Hutch.	Gyamobdebyin	Moist areas	4,000	Fl.	Acidity	Zanskar	July-Sep
<i>Pedicularis cheilanthesifolia</i> Schrenk	Kikimo	Moist places	4,350	Shoot	Stomach complaints	Changthang	July-Sep
<i>Pedicularis longiflora</i> Rud.	Phakchang, Lungri zarpo	Moist places	3,900	Lf., St.	Dry tongue, vertigo boils, diuretic	Leh valley	July-Aug
<i>Pedicularis megalantha</i> D. Don	Lungruk makpo	Marshy	4,400	Fl.	Acidity	Zanskar	June-Aug
<i>Pedicularis pectinata</i> Wall. ex Benth.	Lungri muppo	Moist places	4,000	Fl.	Alopecia	Zanskar	June-Aug
<i>Peganum harmala</i> Linn.	Sepan	Roadsides	3,400	Seeds	Asthma, fever, aphrodisiac	Leh, Nubra valley	July-Sep
<i>Perovskia abrotanoides</i> Karelin		Village areas	3,300	Extracted Oil	Fever, Cooling	Leh valley	June-Sep
<i>Physochlaina praealta</i> (Decne.) Miers	Langthang	Stony slopes, roadsides	3,300	Seeds, Fl.	Toothache	Leh valley	July-Sep
<i>Picrorhiza kurroa</i> Royle ex Benth	Honglen	Moist slopes	4,400	Rt., Fl.	Fever, blood purification	Zanskar	July-Aug
<i>Plantago major</i> L.	Riew kai	Roadside, moist area	3,700	Shoot	Dysentery, indigestion, weakness, diarrhea	Leh, Nubra, Markha, Zanskar	June-Sep
<i>Plantago himalaica</i> Pilger.	Karache, Nikto	Moist area, roadside	3,800	Shoot	Blood purification	Leh, Nubra, Zanskar	June-Sep
<i>Plantago depressa</i> Willd.	Tharam	Roadside	3,800	Shoot	Dysentery	Leh, Drass, Zanskar	June-Sep
<i>Plantago erosa</i> Wall.	Tharam	Trailside	3,400	Whole	Constipation, dysentery, diarrhoea	Leh valley	July-Sep
<i>Pleurospermum angelicoides</i> Benth.	Chhipi	Marshy	4,750	Rt., Fl.	Indigestion	Zanskar	July-Sep
<i>Podophyllum hexandrum</i> Royle	Demobkusu, (Tandik)	Moist shady areas	3,300	Rt.	Skin diseases, blood diarrhoea	Zanskar valley	May-Aug
<i>Polygonum polystachium</i> Wall.	Chutzi nagpo	Moist area	3,400	Zanskar	Acidity, Indigestion	Zanskar	Aug-Oct

Species	Local name	Habitat type	Altitude (m)	Plant parts used	Uses	Locality	Flowering & Fruiting
<i>Polygonum paronychioides</i> C.A. Mey	Nhachu	Moist areas	3,800	Whole	Diarrhea, Dysentery	Zanskar	July-Sep
<i>Potentilla anserina</i> L.		Cultivated, irrigated fields	3,500	Lf.	Diarrhoea, kidney stones, arthritis	Leh, Changthang valley	July-Sep
<i>Potentilla atrosanguinea</i> Lodd.	Chisheng	Alpine slopes	4,650	Whole	Fever	Leh valley	July-Aug
<i>Potentilla fruticosa</i> L.	Khiamgar	Plateau	4,350	Lf.	Fever	Changthang	June-Aug
<i>Potentilla salesoviana</i> Steph.	E-mong karvo	Dry	3,900	Fl.	Itching	Drass, Zanskar	July-Sep
<i>Primula denticulata</i> Smith.		Alpine pasture	4,000	Fl.	Cold	Zanskar, Rumbuk	May-July
<i>Primula macrophylla</i> D. Don	Sulumentok (Kilche)	Moist rocky slopes	5,200	Lf, Rt., Fl.	Cough, joint pain	Leh valley	July-Sep
<i>Primula rosea</i> Royle	Sulumentok	Damp places	4,950	Rt.	Muscular pain	Leh valley	July-Aug
<i>Prunella vulgaris</i> L.	Syangave	Alpine pasture	3,800	Shoot	Lung complaints, Fever	Zanskar, Drass	July-Sep
<i>Psychrogeton andryaloides</i> (DC.) Novop ex Krash.	Lukchung ba	Alpine pasture	3,900	Shoot	Antibiotic	Drass	July-Aug
<i>Pterocephalus hookerii</i> (Cl.) Diels	Spang-tsi-dowo	Dry areas		Lf., Fl.	Cough, cold, diarrhoea, arthritis		July-Sep
<i>Ranunculus brotherusii</i> Freyn	Maokiang	Dry slopes	3,600	Whole	Blood purification	Leh valley	July-Aug
<i>Ranunculus laetus</i> Wall. ex. D. Don	Sharchang	Moist places	3,600	Lf.	Tonic	Zanskar valley	July-Sep
<i>Ranunculus lobatus</i> Jacq. ex. Camb.	Zamtso	Moist places	3,500	Shoot	Toothache	Zanskar valley	July-Sep
<i>Rheum emodi</i> Wall. ex Meissn	Tukshu	Moist rocky	3,700	Rt.	Internal pain	Zanskar	July-Aug
<i>Rheum moorcroftianum</i> Meissn	Tukshu	Marshy	3,900	Rt.	Internal injury	Hemis, Markha	July-Aug
<i>Rheum webbianum</i> Royle	Tukshu	Marshy	4,200	Rt.	Internal injury	Zanskar, Hemis	July-Aug
<i>Rhodiola heterodonta</i> (Hk. f. & T.) Boriss.	Sholo-marvo	Rocky	4,600	Shoot	Cough, Lung infection	Zanskar	July-Sep
<i>Rhodiola imbricata</i> Edgew.	Shrolu	Moist Rocky	4,500	Shoot	Cough	Zanskar	July-Sep
<i>Rhododendron anthopogon</i> D. Don	Balu	Rocky slope	4,100	Lf., Fl.	Internal pain, aphrodisiac	Zanskar	July-Aug
<i>Rosa sericea</i> Lindl.	Rongsal, Syan, Sia	Rocky slope	3,900	Bk., Fl.	Indigestion	Markha, Zanskar	July-Sep

Species	Local name	Habitat type	Altitude (m)	Plant parts used	Uses	Locality	Flowering & Fruiting
<i>Rosa webbiana</i> Wall. ex Royle	Shulik, Rongsal, Syan, Sia	Dry	4,150	Fr., Fl.	Indigestion	Hemis, Nubra	July-Sep
<i>Rumex dentatus</i> L.	Shoma	Marshy	4,100	Rt.	Joint pain	Hemis, Leh, Nubra	June-Sep
<i>Rumex nepalensis</i> Spreng.	Shomang, shobna	Marshy	3,700	Rt.	Wounds	Chillung, Nubra	June-Sep
<i>Sagina saginoides</i> (L.) Karst.	Kanganchoo	Moist area	3,700	Whole	Headache	Zanskar	July-Aug
<i>Saussurea bracteata</i> Decne.	Pang-tsi dowo	Moist rocky, passes	5,200	Fl. Bud, Lf.	Boils, headache, cough, fever, lung infection	Changthang	June-Aug
<i>Saussurea gnaphaloides</i> (Royle ex DC.) Sch.Bip.	Yuliang, pang-tsi	Moist slopes, scree	5,520	Whole	Kidney problem, cough & cold	Leh valley	July-Sep
<i>Saussurea lappa</i> (Decne.) Sch-Bip.	Kut	Cultivated	3,700	Rt.	Dysentery, ulcer, stomachache		Aug-Sep
<i>Saussurea obvallata</i> (DC.) Edgew.	Spangse tobo	Rocky slopes	5,100	Fl. bud	Boils	Leh, Changthang, Nubra valley	July-Sep
<i>Saussurea taraxifolia</i> Wall.		Higher passes	4,800	Fl.	Ulcer, Cold	Zanskar	July-Sep
<i>Saxifraga flagellaris</i> Willd. ex Sternb.	Suchutlikh	Glacial moraines	4,900	Lf., Fl., St.	Fever, Jaundice, Hepatitis	Khardung la	July-Sep
<i>Saxifraga oppositifolia</i> Linn.	Sasomantso	Higher passes	4,650	Shoot	Tonic	Changthang, Nubra valley	July-Aug
<i>Selinum vaginatum</i> (Edgew.) Cl.		Moist slopes	4,200	Rt.	Skin disease	Zanskar	June-Sep
<i>Scorzonera virgata</i> DC.		Sandy places	3,450	Shoot	Intestinal complaints	Leh valley	July-Sep
<i>Scrophularia koelzii</i> Penn.	Yarma	Moist area	3,800	Seed	Sciatica	Zanskar	July-Sep
<i>Scrophularia dentata</i> Royle ex Benth.	Hamchi	Plateau	4,500	Lf.	Stimulate appetite	Changthang	July-Sep
<i>Scutellaria prostrata</i> Jac. ex Benth.	Haunching	Rocky slopes	4,650	Shoot	Fever, jaundice, nerve tonic	Leh valley	Aug-Sep
<i>Sedum crassipes</i> Wall ex Hk.	Churuppa	Moist bouldery	4,300	Shoot	Toothache	Zanskar	July-Sep

Species	Local name	Habitat type	Altitude (m)	Plant parts used	Uses	Locality	Flowering & Fruiting
<i>Sedum ewersii</i> Ledeb.	Churuppa	Moist bouldery	4,800	Shoot	Appetizer, Toothache	Zanskar	July-Sep
<i>Senecio leatus</i> Edgew.	Hechiang	Roadsides	3,800	Lf.	Rheumatism	Zanskar valley	June-Sep
<i>Senecio graciliflorus</i> DC.	Zerjum	Alpine pasture	3,900	Fl.	Headache	Zanskar	July-Sep
<i>Senecio tibeticus</i> Hk. f.	Niyamgar	Plateau	4,350	Lf.	Diuretic	Changthang	June-Aug
<i>Silene moorcroftiana</i> Wall. ex Benth.	Timuksa	Marshy	4,000	Fl., Lf.	Fever	Zanskar	June-Sep
<i>Silene indica</i> Royle ex Otth.	Shukoa, Lugsuk	Moist area	3,800	Lf., Fl., Fr.	Dysmenorrhoea, puerperal infection	Zanskar	June-Sep
<i>Swertia petiolata</i> Royle ex D. Don	Heising	Dry slopes	3,400	Shoot	Tonic	Zanskar valley	June-Aug
<i>Swertia thomsonii</i> Cl. ex Hk. f. & Th.	Tikta	Moist area	4,000	Whole	Fever, Headache	Hunder, Zanskar	July-Aug
<i>Tamaricaria elegans</i> (Royle) Quiser & Ali	Hombuk	River valley	3,700	Shoot	Swelling	Leh, Nubra, Changthang	July-Oct
<i>Tanacetum dolichophyllum</i> (Kitam.) Kitam.	Seigmanlo	Rocky slopes	4,800	Lf., Fl.	Intestinal worms	Changthang	July-Sep
<i>Tanacetum gracile</i> Hk. f. & Thoms.	Khamchu	Stony areas	3,400	Lf., Fl.	Intestinal worms	Leh valley	July-Sep
<i>Tanacetum longifolium</i> Wall.	Bhurse-khampa	Dry	3,700	Lf.	Jaundice	Leh, Markha, Zanskar	July-Sep
<i>Tanacetum nanam</i> Cl.	Phulumentok	Plateau	4,300	Lf.	Intestinal worms	Changthang	July-Aug
<i>Tanacetum tenuifolium</i> Jacq.	Autang	Dry slopes	4,100	Whole	Bodyache, Headache	Leh, Nubra, Hemis	July-Sep
<i>Tanacetum tibeticum</i> Hk. f. & T. ex Cl.	Khurmang	Sandy places, stony slopes	3,600	Lf., Fl.	Jaundice, Intestinal worms	Leh valley	July-Sep
<i>Taraxacum officinale</i> Wigg. Boiss.	Han, (Khurmang)	Marshy	3,450	Rt., St.	Tonic, mouth blisters	Leh, Nubra valley	June-Aug
<i>Thalictrum alpinum</i> L.		Plateau	3,750	Rt., Lf.	Fever	Changthang	July-Aug
<i>Thalictrum foetidum</i> L.	Haichinsah	Cultivated areas	3,600	Rt., Lf.	Diuretic, fever	Leh valley	July-Sep
<i>Thalictrum minus</i> L.	Chak-choo	Wastelands	3,800	Rt.	Conjunctivitis, Fever	Leh, Hemis	July-Aug
<i>Thermopsis inflata</i> Camb.	Khymang chudup	Scree	4,100	Fr.	Swelling	Zanskar	July-Sep

Species	Local name	Habitat type	Altitude (m)	Plant parts used	Uses	Locality	Flowering & Fruiting
<i>Thlaspi arvense</i> L.	Bumak	Roadside, cultivated fields	4,200	Shoot	Gonorrhoea & Swollen testicles	Leh, Nubra, Hemis, Zaskar	June-Sep
<i>Thlaspi montanum</i> L.	Bumuk	Rocky	4,500	Lf.	Cuts & wounds	Zaskar valley	June-Aug
<i>Thymus linearis</i> Benth.	Taksha nakpo	Rocky	4,100	Whole	Tonic	Rumbek, Zaskar	June-Aug
<i>Tragopogon gracilis</i> D. Don	Thar-noo, A khrong	Dry	3,750	Latex	Laxative	Zaskar	June-Sep
<i>Tribulus terrestris</i> L.	Zema ravo	Roadsides, sandy places	3,600	Fr., Fl.	Diuretic, Arthritis, Diabetes	Changthang	July-Aug
<i>Triglochin palustris</i> L.	Puga, Gaika	Dry slopes	3,700	Rt.	Indigestion	Zaskar	July-Aug
<i>Trigonella emodi</i> Benth.	Bhusu hung	Farmland	4,150	Seeds, Lf.	Indigestion, sores	Zaskar	July-Sep
<i>Urtica hyperborea</i> Jacq.	Pachoo, Zasot	Wastelands	5,000	Fl., Lf.	Stomachache, Rheumatism	Khardungla, Ganda la, Taglang la	July-Aug
<i>Urtica urens</i>	Zabo, Zatsut			Lf.	Bodyache		
<i>Veronica macrostemon</i> Bunge ex Ledeb	Shimiogar	High Passes	4,800	Lf.	Skin diseases	Changthang	June-Aug
<i>Viola biflora</i> L.		Alpine pasture	3,800	Shoot	Fever, Cold, Skin diseases	Zaskar	July-Sep
<i>Viola odorata</i> L.		Alpine pasture	4,000	Shoot	Throat ache, Headache, Cold	Zaskar	July-Sep
<i>Waldheimia tomentosa</i> (Decne.) Regel.	Makungla (Lugmik serpo)	Stony slopes	4,650	Lf., Fl.	Septic wounds	Leh valley	July-Sep
<i>Waldhemia glabra</i> (Decne.) Regel	(Sa-palu)	Higher passes	3,400	Whole	Septic wounds	Changthang, Nubra valley	July-Aug
<i>Youngia tenuifolia</i> (Willd.) Babcock & Stebbins	Stathis, Jampa	Rock-crevices	4,000	Lf., Fl.	Jaundice	Zaskar	July-Sep

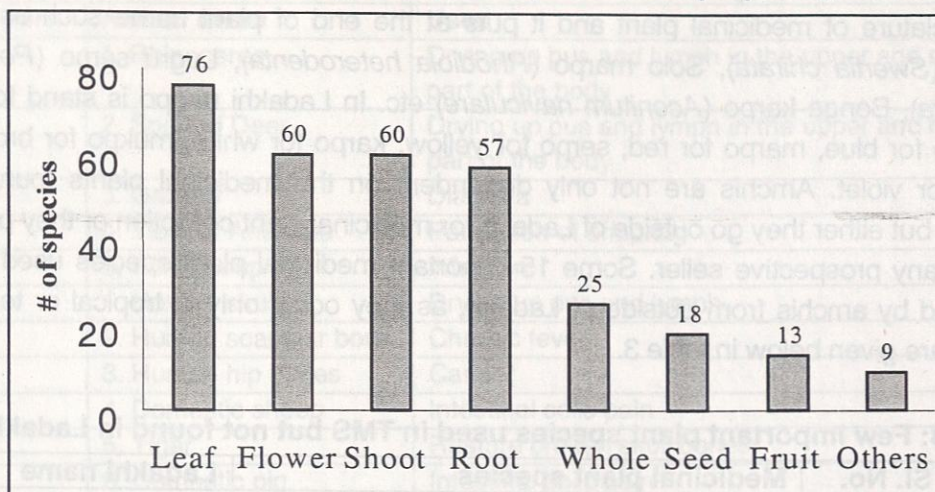
Table 2: Rare and endangered medicinal plant species found in Ladakh.

Species	RDB and CAMP status	Local name	Habitat type	Plant parts used	Uses	Locality
<i>Acantholimon lycopodioides</i> (Girard) Boiss.		Longze	Rocky slopes	Whole	Cardiac disorder	Leh valley
<i>Aconitum balfourii</i> Stapf.	CR EN	Bonga nakpo	Moist areas	Rt.	Sciatica	Zaskar
<i>Aconitum heterophyllum</i> Wall ex. Royle	CR EN	Burna	Moist areas	Rt.	Tonic, diarrhoea, aphrodisiac	Zaskar
<i>Aconitum rotundifolium</i> Kar. & Kir.	R	Bonkar	Dry scrub	Rt.	Cough, blood purification	Zaskar
<i>Aconitum violaceum</i> Jac. Ex Stapf	CR EN	Yangtso (Zinba, Dusi- lama)	Moist areas	Rt.	Cough	Nubra valley
<i>Anaphalis contorta</i> (D. Don) Hk. f.		Telgang	Alpine slopes	Lf., Fl.	Cold & cough	Leh valley
<i>Arnebia euchroma</i> (Royle ex Benth) Johnston	EN	Demok	Rocky slopes	Root	Hair tonic	Leh valley
<i>Artemisia maritima</i> L..	EN	Khamchu	Stony slopes	Lf., Fl head	Fever	Leh, Nubra valley
<i>Bergenia stracheyi</i> (Hk. f. & T.) Engl.	VU	Dak-kya-hawo, Gatikpa	Rocky	Rt., Fl.	Blisters	Zaskar
<i>Betula utilis</i> D. Don	EN	Takpa	Rocky	Bk., Lf.	Jaundice, burns, wounds	Zaskar
<i>Cremanthodium ellisii</i> (Hk. f.) Kitam.		Dariya kan		Lf., Fl.	Fever	Khardung-la
<i>Dactylorhiza hatagirea</i> (D. Don) Soo.	CR	Sanchu (Angbolakpa, wangluk)	Moist places	Tuber	Kidney complaints, aphrodisiac	Nubra valley
<i>Delphinium brunonianum</i> Royle		Lunde-kaown	Moist rocky slopes	Seeds	Insecticide	Changthang
<i>Delphinium cashmerianum</i> Royle	R	Lunde-kaown (Cha- gotpa)	Stony slopes	Seeds, Shoot, Fl	Insecticide, colic, throat-ache	Leh valley
<i>Ephedra Gerardiana</i> Wall. ex Stapf.		Chhapat (Tse)	Stony slopes, gravelly soil	St.	Asthma, fever, bronchitis, rheumatism	Leh, Nubra valley
<i>Ferula Jaeschkeana</i> Vatke	VU	Thunak, Risho	Dry slopes	Rt., Seeds	Chest pain	Drass
<i>Fritillaria roylei</i> Hook.	CR EN	Chikmo	Alpine slopes	Bulbs	Asthma, tonic	Zaskar valley
<i>Gentiana kurroa</i> Royle	EN	Pangyin	Moist slopes	Fl.	Cough	Zaskar
<i>Geranium sibiricum</i> L.		Eyamlomentok	Sandy, wetlands	Lf.	Diarrhea	Nubra

Species	RDB and CAMP status	Local name	Habitat type	Plant parts used	Uses	Locality
<i>Heracleum lanatum</i> Michx.	EN	Tunak, tukar	Marshy	Fl., Lf.	Liver complaints, Arthritis	Drass
<i>Herninium monorchis</i> (L.) R. Br.			Moist places	Tuber	Kidney complaints	Nubra valley
<i>Hippophae rhamnoides</i> L	LR-NT	Tar-ngoo, Starbu, Zing	Riverbeds	Fr.	Lung infection	Leh, Nubra
<i>Hyoscyamus niger</i> L.	LR-NT	Thangdum, langtang- tse	Village site	Fr.	Toothache	Leh, Nubra, Hemis
<i>Inula racemosa</i> Hk. f.	CR EN (CAMP) R (RDB)	Manu	Cultivated	Rt., Fl	Gastrointestinal, Rheumatism	
<i>Juniperus communis</i> L.	R	Shukpa	Dry slopes	Fr., Lf.	Kidney disorder	Drass, Kargil
<i>Juniperus recurva</i> D. Don	R	Shukpa	Dry slopes	Shoot	Kidney disorder	Drass, Zaskar
<i>Lancea tibetica</i> Hk. f. Th.	R (RDB)	Payak-tsa	Marshy	Seeds	Cough, blood vomiting	Zaskar
<i>Lloydia serotina</i> (Linn.) Reichb.		Kangkar (Tsa-awa), Anwa	Alpine passes	Tuber, Lf.	Blood purification, fever, eye infection	Nubra valley
<i>Meconopsis aculeata</i> Royle	CR	Serhun, Tsergnon	Stony desert	Lf., Fl., Fr.	Fracture, Tonic	Zaskar
<i>Physochlaina praealta</i> (Decne.) Miers	VU	Langthang	Stony slopes, roadsides	Seeds, Fl.	Toothache	Leh valley
<i>Picrorhiza kurroa</i> Royle ex Benth	EN (CAMP) R (RDB)	Honglen	Moist slopes	Rt., Fl.	Fever, blood purification	Zaskar
<i>Podophyllum hexandrum</i> Royle	EN	Demobkusu, (Tandik)	Moist shady areas	Rt.	Skin diseases, blood diarrhoea	Zaskar valley
<i>Primula rosea</i> Royle		Sulumentok	Damp places	Rt.	Muscular pain	Leh valley
<i>Rheum emodi</i> Wall. ex Meissn	VU	Tukshu	Moist rocky	Rt.	Internal pain	Zaskar
<i>Rheum moorcroftianum</i> Meissn	VU	Tukshu	Marshy	Rt.	Internal injury	Hemis, Markha
<i>Rheum webbianum</i> Royle	VU	Tukshu	Marshy	Rt.	Internal injury	Zaskar, Hemis
<i>Rhododendron anthopogon</i> D. Don	VU	Balu	Rocky slope	Lf., Fl.	Internal pain, aphrodisiac	Zaskar

Species	RDB and CAMP status	Local name	Habitat type	Plant parts used	Uses	Locality
<i>Saussurea bracteata</i> Dcne.	R (RDB)	Pang-tsi dowo	Moist rocky, passes	Fl. Bud, Lf.	Boils, headache, cough, fever, lung infection	Changthang
<i>Saussurea gnaphaloides</i> (Royle ex DC.) Sch.Bip.	R	Yuliang, pang-tsi	Moist slopes, scree	Whole	Kidney problem, cough & cold	Leh valley
<i>Saussurea lappa</i> (Decne.) Sch-Bip.	CR EN (CAMP) R (RDB)	Kut	Cultivated	Rt.	Dysentery, ulcer, stomachache	
<i>Saussurea obvallata</i> (DC.) Edgew.	VU	Spangse tobo	Rocky slopes	Fl. bud	Boils	Leh, Changthang, Nubra valley
<i>Selinum vaginatum</i> (Edgew.) Cl.	LR-LC		Moist slopes	Rt.	Skin diseases	Zaskar
<i>Tanacetum nanam</i> Cl.		Phulumentok	Plateau	Lf.	Intestinal worms	Changthang
<i>Thymus linearis</i> Benth.	CR EN	Taksha nakpo	Rocky	Whole	Tonic	Rumbek, Zaskar
<i>Waldheimia tomentosa</i> (Decne.) Regel		Makungla (Lugmik serpo)	Stony slopes	Lf., Fl.	Septic, wounds	Leh valley
<i>Waldheimia glabra</i> (Decne.) Regel		(Sa-palu)	Higher passes	Whole	Septic, wounds	Changthang, Nubra valley

Fig 5: Use of number of plant species parts by amchis in preparing medicine



Medicine name: –A-gar 8
 Composition: *Aquilaria agallocha*
Myristica fragrans
Bambusa textilis
Saussurea lappa
Terminalia chebula
Melia composita
Commiphora camphora
Mesua fernea

Medicine name: A-phyag
 Composition: *Chrysanthemum tatsiensense*
Arenaria glanduligera
Terminalia chebula
Veronica ciliata
Picrorhiza kurrooa

Medicine name: A-ru 7
 Composition: *Terminalia chebula*
Mesua ferrea
Eugenia caryophyllata
Piper longum
Herpetospermum caudigerum
Amomum subulatum
Nardostachys jatamansi

Interviews with amchis for the inventory of medicinal plants made it clear that there is lot of ambiguity in taxonomy. In practice sometime amchis use different names for the same plant and sometime one name for different species. In old transcriptions the Tibetan plant names are described with their medical function, but not always accompanied by a precise illustration. As a result amchis have not unambiguous insight in the taxonomy and application of the medicinal plants. Many times the particular plant could not be found and

a replacement is being used. The colour of flower plays an important role in the local nomenclature of medicinal plant and it puts at the end of plant name such as, Sgatig nagpo (*Swertia chirata*), Solo marpo (*Rhodiola heterodonta*), Lugru serpo (*Pedicularis longiflora*), Bonga karmo (*Aconitum naviculare*) etc. In Ladakhi nagpo is stand for black, wongpo for blue, marpo for red, serpo for yellow, karmo for white, mukpo for brown and janku for violet. Amchis are not only dependent on the medicinal plants found within Ladakh but either they go outside of Ladakh for medicinal plant collection or they purchase it from any prospective seller. Some 15 important medicinal plant species used in TMS gathered by amchis from outside of Ladakh, as they occur only in tropical or temperate areas, are given below in table 3.

Table 3: Few important plant species used in TMS but not found in Ladakh

Sl. No.	Medicinal plant species	Ladakhi name
1	<i>Aegle marmelos</i> Corr.	Bilva
2	<i>Pongamia pinnata</i> Pierre.	Karanja
3	<i>Embllica officinalis</i> Gaertn.	Amalaki
4	<i>Acacia catechu</i> Willd.	Stol za
5	<i>Cassia tora</i> L.	Thalka dorje
6	<i>Ricinus communis</i> L.	Danrog
7	<i>Bombax ceiba</i> L.	Nagagesar
8	<i>Butea monosperma</i> (Lam.) Kuntze	Maruze
9	<i>Melia azadiracta</i> L.	Smag shing
10	<i>Morus alva</i> L.	Ose
11	<i>Caesalpinia spiaria</i> Roxb.	Shing kun
12	<i>Cupressus torulosa</i> D. Don.	Shukpal brugu
13	<i>Punica granatum</i> L.	Sebru
14	<i>Terminalia chebula</i> Retz.	Arura
15	<i>Woodfordia fruticosa</i> (L.) Kurz	Sindura

Apart from higher plants (Angiosperms, Gymnosperms and Pteridophytes) the lower plant species such as lichens are also used in preparing medicine by amchis. For curing chronic fever and poisoning lichens are mixed up with other ingredients and a medicine is developed.

4.4.7 Use of Animal Parts

The use of animal parts in the treatment of various ailments is quite prevalent in the TMS. Amchis keep animal organs in their medicine bags and clinics. Almost 38 species of animals and their organs used in therapy were documented during the survey of which 31 are wild animals (Table 4). These animals are distributed globally from ocean (corals) to high altitudes of Himalaya (bharal, Tibetan Antelope). The use of wolf tongue and antelope horns admitted by 95% of amchis which indicates the value of these organs in Tibetan medicine. The most costly organs used in medicine are musk of musk deer and gall bladder of elephant that costs in market are around Rs. 6000/- and Rs. 5000 respectively. If available, amchis take the human heart, fresh blood and flesh of a person who died in an accident or infighting and use these in epilepsy.

Table 4: Animal parts and their uses in Tibetan medicine.

Animal part	Animal name	Uses
Horns	1. Rhinoceros	Drying up pus and lymph in the upper and middle part of the body
	2. Spotted Deer	Drying up pus and lymph in the upper and middle part of the body
	3. Gazelle	Diarrhea
	4. Tibetan Antelope	Parturition of offspring
	5. Wild sheep	Infection
Bones	1. Human skull	Drying up pus and lymph
	2. Human scapular bone	Chronic fever
	3. Human hip bones	Cancer
	4. Domestic sheep	Intestinal colic pain
	5. Tiger	Restore broken skull bones
	6. Domestic pig	Intestinal colic pain
	7. Monkey	Helps in child birth
	8. Ungulate bones	Diseases affliction by lymph
Flesh	1. Human	Poison, plague
	2. Snake	Eye complaints
	3. Vulture	Stimulates power of digestion
	4. Peacock	Poisoning
	5. Otter liver	Reproductive disorder
	6. Marmot liver	In bone fracture
	7. Domestic goat liver, lung, kidney	Useful for eyes, lung disorder
	8. Wolf tongue, stomach	Tongue cures inflammation and stomach stimulates power of digestion
	9. Pig tongue	Cures growth of nodules in the bones
	10. Dog tongue	Ulcer
	11. Ass tongue	Diarrhea
	12. Fox lung	Ulcer of lungs
	13. Bat	Vomiting
	14. Sparrow	Promotes semen production
	15. Lizards	Promotes semen production
	16. White-breasted Dipper	Meat poisoning
Blood	1. Deer	Parasitic infection
	2. Goat	Small pox
	3. Wild yak	Diarrhea
	4. Corals	Fever
	5. Pig	Poisoning
	6. Ass	Rheumatism, eyes complaints
Fat	1. Snakes	Extraction of arrow
	2. Deer	Parasitic infection
	3. Pig	Poisoning
Skin	1. Snakes	Leucoderma, eczema
	2. Rhinoceros	Small pox
	3. Mouse	Extraction of pus
	4. Bull	Small pox
Nails	1. Crocodile	Fever
	2. Ass hoof	Reproductive disorder
	3. Horse hoof	Tumors

Animal part	Animal name	Uses
Hair, feathers	1. Peacock	Poisoning
	2. Owl	Ascetics
	3. Bharal hairs	Poisoning
Urine/stool	1. Cow urine	Chronic fever
	2. Vulture droppings	Power of indigestion
	3. Pig droppings	Tumor
	4. Horse droppings	Parasitic infection and vomiting
	5. Rabbit droppings	Ascites
	6. Pigeon droppings	Inflammatory oedema
	7. Ground beetle	Colic pain
	1. Musk deer	Antibiotics
	2. Elephant gall bladder	
	3. Common leopard bile	Pulmonary and bronchial diseases
	4. Snow leopard bile	Bronchial and pulmonary disorder
	5. Bear bile	Pulmonary affliction

4.4.8 Use of Minerals

Many minerals and stones are used in combination with herbs for the treatment of different ailments. During this survey the use of 6 minerals were documented by amchis (Table 5). The most important and widely used mineral is shilajit. In Ladakhi shilajit is called Tak-Joon, which means rock extract. In Ladakh shilajit is mainly found in Brug Mar (Red rock) of Hemis, Melong Drak (mirror rock) of Tia, Jon (rock form) of Skindiyang, Hong (valley) of Skindiyang, Nyerma and Yarpa Gongma of Dumkhar.

Table 5: Minerals and their uses in Tibetan medicine

Sl. No.	Mineral/stones	Uses
1	Gold	Promotes longevity
2	Silver	Dries up pus
3	Copper	Cures fever, dries up pus
4	Iron	Cures liver poisoning, eye diseases, anemia
5	Pearls	Poisoning
6	Stones	Useful in therapy
7	Shilajit	Longevity, rejuvenation,

4.4.9 Treatment by Cold and Hot Water

Amchis prescribe to take or not to take bath in curing certain disorders. As per their prescription bath promotes the power of digestion, strength, longevity and energy. It cures itching, excessive perspiration, laziness, fetid smell, and burning sensation of the body. Rainwater, which has no taste, considers pure and prescribes as cordio-tonic. As per amchi's opinion it promotes longevity. In certain ailments bath is not suggested by amchis especially for the persons suffering from diarrhea, flatulence, chronic cold, and indigestion. Bath after having food is discouraged. Hard bath with hot water is considered harmful for the hair, eyesight, and health. Use of stable water is highly discouraged and considered the major cause of filariasis and heart diseases.

There is some hot springs in different valleys of Ladakh such as Chumathang, Panamik, Chilling, Markha, Serchan, and Pugga with a large amount of sulfur and minerals. Bath in sulfur springs water is recommended for the people who suffer from rheumatism. There are some mineral springs, which flow at certain season of the year and possess medicinal properties for a limited period. That limited period is prescribed by amchis for taking bath. Particular hot water spring is recommended in curing few particular diseases. For instance, Chumathang is recommended in curing back pain, Markha in itching, and Chilling in back pain and sciatica.

4.4.10 Prescriptions for Patient in TMS

Selection of proper diet and drugs for good health is emphasized in Tibetan medicine. Apart from what food one takes, how food is taken, is important for good health. The environment in which food is to be taken and the combinations of different types of ingredients play important roles. If the person taking food is not peaceful in mind, and takes food in hurry, then even good food does not provide good health. According to amchis, taking food when person is angry, fearful or anxious effects the functioning of the gastro-intestinal tract including liver and pancreas that result in causing several diseases. Depending upon the different parts of the day and night and different times of taking food, medicine is prescribed for use. The combination of different meals prescribed for patient is also highlighted in both Tibetan medicine and Ayurveda. Amchis discourage patient and even the healthy person not to take fish and milk together. It is believed that fish and milk are individually good for health but when taken together, they produce serious health hazards.

One should bear it in mind that the therapeutic efficacy or potency of each medicine are brought into existence and propounded by all the sagas. Every creature that has taken birth has to die, as death is an eternal truth and it is the law of nature. Amchi tries his best to make the person healthy and happy till death. They have the philosophy that in old age nobody should be a liability upon the family, society and the government. According to Charak (Charak Samhita), persons living close to nature remained free from diseases. They succumbed to diseases when they adopted various artificial modes of living. Amchis believe that in present so-called civilized world, civilization has become synonymous with artificial living and behaviour. People who lead more of artificial way of living are considered more or more civilized. The pleasure one gets in the artificial living is transitory, and it inflicts more miseries in the long run. In the nature lies the secret of healthy life.

4.4.11 Future of TMS

The system of Tibetan medicine is declining in Ladakh as among the new generation very few persons come forward to adopt amchi as a profession. Over the years there has been many changes within the profession. The old amchis have good knowledge on the medicinal plants and are able to identify these plants in the field. Whereas many new amchis (some of them are trained in Dharamsala) are not able to identify the plant species due to their major dependency on prepared medicine which they purchased

from outside. It is praiseworthy that state Govt., few NGOs and many old amchis are doing their best to keep the tradition continue and alive. Building up new associations and amchi schools are in progress within and outside of Ladakh. At the same time TMS has gained a considerable momentum in the western countries. The Tibetan herbal products in China are well known to the world.

At present, there are two ways to become a Tibetan doctor (amchi), one way through formal certified training and second through internship. Formal qualifications have been introduced, primarily in the main teaching schools offering seven-year formal training courses. The formal training for Tibetan Doctors takes place in the established medical schools that are not part of the monastic tradition. The courses for students include memorization of medical texts, medical theory, practice of pharmacy, use of herbals and minerals, collection and recognition, Tibetan grammar, debate on Tibetan medicine, medical astrology and astronomy. At last stage of training emphasis is given to practical work in which students spend 2 years in a clinic with a senior doctor before they are fully qualified to practice alone.

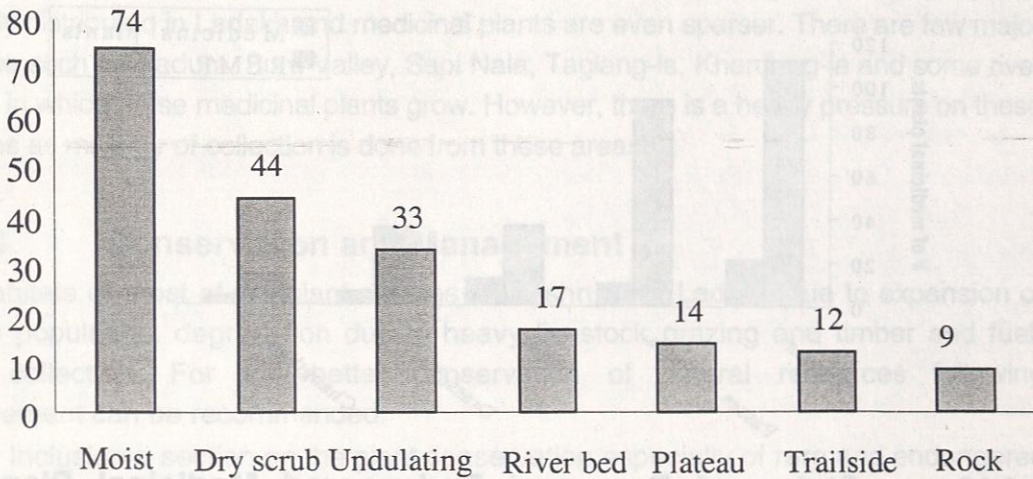
To inculcate the sense of belongings within communities and to flourish the Tibetan medical knowledge globally His Holiness the 14th Dalai Lama in exile established the Men-Tsee-Khang (Tibetan Medical and Astrology Institute - TMAI) at Dharamsala in Northern India. The Men-Tsee-Khang in Lhasa, Tibet, continues to provide education and training in Tibetan medicine. The Ladakh School of Tibetan Medicine in Ladakh runs on the same basis as the Men-Tsee-Khang and is closely affiliated to the TMAI of Dharamsala. Apart from this, there is a Tibetan Medical Center in Darjeeling, India that has a strong links with the monastic tradition and only accepts men as students. Established in 1993 the Tibetan Medical School, Central Institute of Higher Tibetan Studies, in Sarnath, Varanasi, India also runs a seven-year recognized course. Besides the Tibetan medical course, Sanskrit and the Tibetan language are taught at graduate level to facilitate research work at the institute. Recently at Tungri in Zaskar valley an amchi institute has been set up in which out of total 20 half of the students are female.

Creation of amchi associations recently in 1999 such as Traditional Medico-Cultural Association and Yuthog Foundation are dealing with the preservation and promotion of TMS. The aims of these associations are to provide health care facilities for the poor and rural section of the societies. NOMAD, an NGO, at Leh is also dealing in popularising the traditional system of medicine of Ladakh. In general, attempts being made by different sections of the societies to gear up this age-old tradition.

4.1.12 Best Localities of Medicinal Plants in Ladakh

All 285 medicinal plants found in Ladakh are distributed over different localities and habitats. Only few plants are uniformly distributed and occur throughout the Ladakh, however most of the medicinal plants are localized and restricted to few localities and habitats (Fig 6). The highest number of medicinal plant species (74 species) are restricted to marshy and moist rocky areas followed by dry scrub (44 species) and undulating lands (33 species).

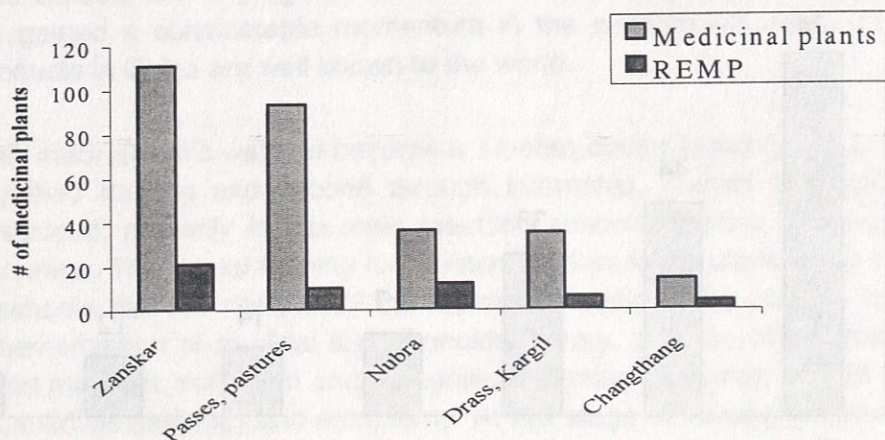
Fig 6: Distribution of medicinal plants across different habitat types



Usually amchis collect medicinal plants from the nearby areas of their villages, however most of the medicinal plants are collected from high passes and pastures. If the desirable species is not available in the nearby areas then they share the medicinal plants with other amchis who possess the needed medicinal plants. Based on interviews of amchis total 35 localities were recorded from where the collection is made. About 80% of amchis collect medicinal plant from Zaskar region followed by high passes such as Khardung-la, Taglang-la, and Stok Kangri Nalas (Fig 7). Within Zaskar most of the plants are collected from Sapi Nala, Padum, Rangdum, Ralakunb, Sinku-la, and Talish localities. Some localities such as Kangi Nala and Phokar are visited by number of amchis for herb collection. The collection of medicinal plants is done mainly during the end of August and in September when the plants are in full bloom or mature.

Amchis of different valleys also collect plants from their adjacent areas. For instance, amchis of Changthang plateau collect medicinal plants from Korjok Nala, Hunley, Taglang-la and Tibetan Refugee Sumdo including Rohtang pass, which is outside of Ladakh. Amchis of Nubra Valley collect plants from Hunder, Sumur, Panamik, Siachen and Khardung-la. Amchis of Indus valley collect plants from Stok Kangri Nala, Phan, Mankarmo, Chhortangen, Khardung-la, Shyang (Hemis), Pullu, Docks, Phoche, Scangris (above Alchi) and Markha valleys. There are many rare and endangered medicinal plants in Ladakh. Sapi Nala, Sinku-la, Phokar, Rangdum, Khardung-la and Taglang-la are the major localities of these valuable rare plants.

Fig 7: Distribution of rare, endangered and medicinal plants across different localities in Ladakh



4.4.13 Status of Rare and Endangered Medicinal Plants of Ladakh

To know the status of rare and endangered medicinal plant is prerequisite in developing strategies for their long-term conservation. To investigate the habitat association and distribution of rare medicinal plants are must for identifying the structures and elements that are critical for their occurrence. A total of 54 rare and endangered plant species are found in Ladakh of which 46 species are of medicinal value. Out of total 46 rare and endangered medicinal plant 8 are critically endangered, 7 endangered, 8 vulnerable, 8 rare, 2 low-risk near threatened and 1 is low risk least concerned as per the CAMP workshops (Ved and Tandon 1998) and Red Data Book of Indian Plants (Nayar and Sastry 1987). Rests of the 12 rare medicinal plants are mentioned in secondary literature. Most of the rare medicinal plants (25 species) grow on the marshy and moist rocky areas. Two species i.e. *Inula racemosa* and *Saussurea costus* are cultivated species and not seen in wild. The highest number of rare medicinal plants (17 species) were found in Zaskar valley followed by High passes/pastures (8) and Nubra (6 species).

The rarity in these medicinal plants is due to habitat loss, narrow range of distribution and over-harvesting. A similar trend was found in the Trans-Himalayan region of Lahaul-Spiti by Kala (2000). A major threat for the species that is uprooted and its underground parts such as rhizomes, tubers, bulbs and roots are used in medicine. *Dactylorhiza hatagirea* (Angbolakpa, Hathajari, Salampanja), *Picrorhiza kurroa* (Honglen, Katuki), *Rheum webbianum* (Tukshu, tatra), *R. tibeticum* (Tukshu), *Aconitum heterophyllum* (Bonna karmo, Atis), *Aconitum violaceum*, etc are such species which have become endangered throughout the Himalayan and Trans-Himalayan region due to over-collection.

The other rare and endangered species of medicinal plants in Ladakh are *Saussurea gnaphaloides* (Pangtsi), *Podophyllum hexandrum* (Olmoselo, tandik), *Lancea tibetica* (Payogtsa) and *Rhododendron anthopogon* (Balu). The proper cultivation technology of these species is not yet developed so that these species may be cultivated at large scale

to fulfill the requirements of amchis. Moreover, pharmaceutical companies and amchis both prefer to use the wild resources, as it is believed that the effectiveness of cultivated varieties of medicinal plants is lesser than its wild relatives. The vegetation is scanty and sparsely distributed in Ladakh and medicinal plants are even sparser. There are few major localities such as Padum, Suru Valley, Sapi Nala, Taglang-la, Khardung-la and some river valleys in which these medicinal plants grow. However, there is a heavy pressure on these localities as majority of collection is done from these areas.

4.4.14 Conservation and Management

The habitats of most of the plant species have shrunk in Ladakh due to expansion of human population, degradation due to heavy livestock grazing and timber and fuel-wood collection. For the better conservation of natural resources following improvement can be recommended.

1. Inclusion a section on the plant conservation especially of rare and endangered medicinal plants in the Wildlife Protection (Act).
2. Promotion of community based conservation.
3. In-situ conservation through the establishment of nature reserves or biosphere reserves.
4. Ex-situ conservation through tissue culture and developing medicinal plants nurseries.
5. To conduct regular training on the procedure of medicinal plants collection, and processing among the amchis, traders, and real stakeholders.

Traditional methods of utilization of natural resources in many cases are graded as sustainable, where demands of the population have not strained the resilience of the surrounding environment. The local communities are believed to be the good managers of their own resources. This thought has gained momentum in the recent past and in many cases this has been substantiated through examples across the country. The knowledge behind traditional systems requires recognition, respect and understanding. The greatest challenge in the new millenium is integration of the indigenous knowledge system with the new and modern ones to decelerate the pace of environmental degradation. Moreover, once the commercialization takes place in natural resources and people oriented towards making more money it creates a severe problem in paradigm of conservation. There is an urgent need to educate the local people and amchis about sustainable harvesting techniques so that the present pressures on medicinal plants especially of rare and endangered categories can be minimized in Ladakh. Collection should only be done in areas where plants grow properly. Plant parts should be collected during autumn after the vegetative processes are ceased. Meanwhile, proper cultivation technology needs to be developed, established and promoted at large scale in this part of Himalaya. The Zaskar area can be a best site for the cultivation of these medicinal plants as it has favorable and suitable environment for medicinal plant cultivation. Field Research Laboratory (FRL) and Forest Dept. at Leh has started cultivating these medicinal plants in some nurseries which is a step forward in the area of conservation of these valuable medicinal plants.

References

- Aswal, B.S. and Mehrotra, B.N. 1985. Contribution to the flora of Lahul valley, North West Himalaya. *J. Econ. Tax. Bot.* 7, 299-307.
- Aswal, B.S. and Mehrotra, B.N. 1994. *Flora of Lahaul-Spiti (A Cold Desert in North West Himalaya)*. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.
- Balodi, B. and Singh, D.K. 1997. Medico-ethnobotany of Ladakh. *Annals of Forestry*, 5 (2): 189-197.
- Chaurasia, O.P. and Singh, B. 1996. *Cold Desert Plants*. Vol I-IV. Field Research Laboratory, DRDO, Leh, India.
- Chaurasia, O.P., Singh, B. and Sareen, S.K. 1999. Ethno-medico-botanical survey of Nubra valley. *J. Econ. Tax. Bot.*, 23 (1): 167-172.
- Dash, B. 1976. *Tibetan Medicine*. Library of Tibetan Works and Archives, Dharamsala, India. 390 pp.
- Dash, B. 1994. *Encyclopaedia of Tibetan Medicine*. Sri Satguru Publications, Delhi, India. Vol. I-III.
- Dommer, T. 1988. *Tibetan medicine and other holistic health care systems*. Routledge, Chapman and Hall, New York. 307 pp.
- Fox, J.L., Nurbu, C., Bhatt, S. and Chandola, A. 1994. Wildlife Conservation and Land-use Changes in the Trans-Himalayan Region of Ladakh, India. *Mountain Research and Development* 14, 39-60.
- Jina, P.S. 1996. *Ladakh: The Land and the People*. Indus Publishing Company, New Delhi. 288 pp.
- Kala, C.P. 2000. Status and conservation of rare and endangered medicinal plants in the Indian Trans-Himalaya. *Biol. Conserv.*, 93 (3): 371-379.
- Kala, C.P. and Manjrekar, N. 1999. Ethno-medicobotany of Indian Trans-Himalaya: A case study from Spiti. *J. Econ. Tax. Bot.* 23 (1): 177-183.
- Khangkar, L.D. 1985. *An introduction to Tibetan medicine*. In Tibetan Medicine Series 9. Library of Tibetan Works and Archives. 3-15.
- Khangkar, T.D. 1990. *Health and harmony through the balance in pulse rhythms*. Yarlung Publications, New Delhi, 48 pp.
- Manjrekar, N. 1998. *A Study of the Local Health Traditions of Spiti*. The Report, Foundation for Revitalisation of Local Health Traditions, Bangalore.
- Namgyal, G. and Phuntsog, S.T. 1990. *Amchi pharmaco-therapeutics*. Central Council for Research in Ayurveda and Siddha. Printed at Cambridge Printing Works, New Delhi. pp 330.
- Nayar, M.P. and Sastry, A.R.K. 1987. *Red Data Book of Indian Plants*. Botanical Survey of India, India.
- Norberg-Hodge, H. 1999. The march of the monoculture. *The Ecologist*, 29 (2): 194-197.
- Sharma, J.P. and Mir, A.A. 2000. (Eds). *Dynamics of Cold Arid Agriculture*. Kalyani Publishers, Ludhiana, India. 338 pp.
- Rodgers, W.A., Panwar, H.S. and Mathur, V.B. 1998. *Wildlife Protected Area Network: A Review*. Wildlife Institute of India, Dehra Dun.
- Tsarong, T.J. 1986. *Handbook of Traditional Tibetan Drugs*. Tibetan Medical Publications. 101 pp.
- Ved, D.K. and Tandon, V. 1998. *CAMP Report for High Altitude Medicinal Plants of Jammu-Kashmir and Himachal Pradesh*. FRLHT, Bangalore, India.

Chapter 5

Insect Survey in Ladakh

by V.P. Uniyal

5.1 Introduction

Insects are a major component of the world's biodiversity. By virtue of their vast numbers of both species and individuals, they are vital determinants of terrestrial ecological processes. Quantitatively, insects are important pointers for species-rich geographical areas. Qualitatively, they are also important, whether, the subject of conservation themselves or as a tool for identifying areas with high endemism.

Insects are a dominant and ancient group of animals on the earth. Over one and half million living and about 12,000 species of fossil insects have been identified and described all over the world and they represent about 90 per cent diversity documented for the animal kingdom. Nearly one tenth of the insect species are still unidentified. Several species are believed to have become extinct without even being identified.

5.1.1 High Altitude Entomology: An Overview

Von Hugel made the first record of insect collection from Himalayas in the first half of the last century (Singh, 1983), later Kollar and Redtenbacher identified his collection during 1848 that comprised several hundred species. Co. Stoliczka conducted the next attempt for insect collection from the Himalayan region under the Yarkand Mission in 1872. He worked extensively in the northwest Himalaya and documented the insect diversity. Later on, many professionals and amateurs have made insect collections in different expeditions of the Himalayan region. The important among them are the North Indian expedition, Italian Karakoram and German Nanga Parbat expedition and several successive Everest expeditions (Singh, 1983). Practically all insect collections from the high altitude areas provided adequate information on insect faunal diversity, but none of these studies paid any attention to the numerous complex and interacting ecological factors that govern the distribution and existence of such a fantastic variety of insect life at the extreme high elevations. No serious effort was also made to uncover the biographical affinities and evolutionary tendencies of the high altitude insect fauna by most of these early explorers.

The credit for advancement in high altitude entomology goes to M. S. Mani (1954) for his untiring work on high altitude insect life. He and his associates organised many entomological expeditions during the last twenty-five years and published a series of papers on the faunistics, systematics, field ecology and biography of the high altitude insects. In more recent years Mani (1962); Mani and Singh (1955); Khan and Sahni (1978); Kulshrestha (1978); Uniyal and Mathur (1998, 1999, 2001); Uniyal (1999) and Uniyal, *et al.*, (2000) have surveyed insect fauna of Himalayan regions and described various aspects of insect life.

Mani and Santokh Singh (1962) have conducted the entomological surveys of North-West Himalaya under their four years long study of the Himalayan region and described the nival zone insects belonging to an ecologically specialised, cold adapted region. They have surveyed the high altitude areas of Himachal Pradesh, Jammu and Kashmir including some part of Ladakh and documented 14 insects orders with 394 nival zone species. Maheshwari (1989a) surveyed various lakes of Ladakh and studied the distributional patterns and bioindicator community of Chironomidae (Diptera).

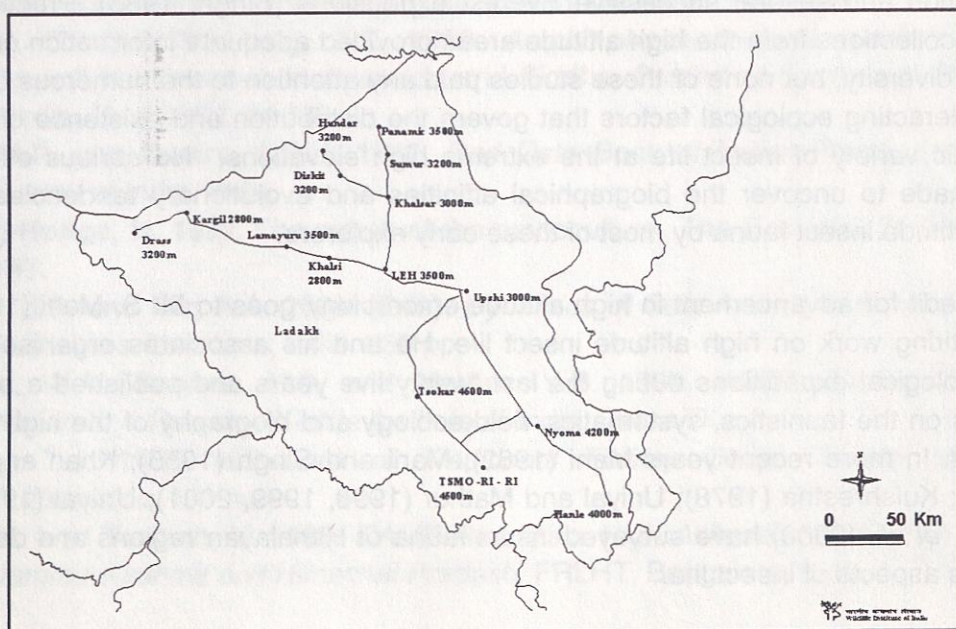
5.2 Objectives

- ◆ Developing a checklist of insect species of different areas of Ladakh.
- ◆ Baseline survey of insect association with vegetation communities, topographic and climatic features.
- ◆ To standardize the insect sampling techniques.
- ◆ To prepare a map of high level of endemism/rare insects.

5.3 Study Area

The present study was undertaken in four different regions of Ladakh viz., Changthang WL Sanctuary, Karakoram WL Sanctuary and Kargil areas. The insect collections were conducted in 17 different locations of the four regions (**Map 1**). The Ladakh region lies to the West of the Tibetan plateau and has been variedly referred to as a plateau, tableland, moonland, roof of the earth, cold desert etc. The Ladakh area has mighty mountain ranges, high peaks and mountain passes, gigantic glaciers, enchanting high altitude lakes, long river valleys (Indus valley), vast glaciated high altitude plains, superheated thermal springs and a rich Buddhist culture. The present study was conducted in the following areas of Ladakh.

Map 1. Locations of Insect Survey in Ladakh



Area Surveyed with its general altitude:

1. *Changthang WL Sanctuary*

- ◆ Tso-Moriri - 4, 500 m
- ◆ Nyoma - 4, 200 m
- ◆ Tsokar - 4, 600 m
- ◆ Hanle - 4, 000 m

2. *Karakoram WL Sanctuary*

- ◆ Khardungla - 5, 500 m
- ◆ Khalsar - 3, 000 m
- ◆ Sumur - 3, 200 m
- ◆ Panamic - 3, 500 m
- ◆ Hundar - 3, 200 m
- ◆ Diskit - 3, 200 m

3. *Leh area*

- ◆ Shankar - 3, 500 m
- ◆ Shey - 3, 000 m
- ◆ Thikse - 3, 000 m
- ◆ Khalsi - 2, 800 m
- ◆ Lamayuru - 3, 500 m

4. *Kargil area*

- ◆ Kargil - 2, 800 m
- ◆ Drass - 3, 200 m

5.4 Methods

Insect collection was made in different locations of the regions of Ladakh. The areas selected for collection comprised various type of habitat at different altitude viz., aquatic marsh, pastures, alpine vegetation, agriculture fields etc. The collection was carried out in the early hours of the day because most of the flying insects like butterflies and bees are usually active in early sunrise so it was easy to observe them. The following methods were adopted to collect diurnal and nocturnal insects.

Hand picking - Small insects of order coleoptera were collected by hand with the help of fine forcep. The forcep was used carefully to avoid damage to the insect.

Aerial netting - The insect net was used to collect free living flying insects like butterflies, dragonflies and bees etc.

Trapping - As most of the insects attract towards light source, the collection was done by using light trap in different habitat.

5.5 Significant Findings

Keeping in view the diverse and characteristic features of insects and their value as indicators for biodiversity monitoring, the insect survey was conducted in four regions of Ladakh between 2,800 to 5,500 m in the month of July 2000. A total of 7 insects orders (Coleoptera, Lepidoptera, Hymenoptera, Diptera, Orthoptera, Odonata, and Plecoptera) including 28 different families with 38 species have been identified so far and about 75 species of different groups are in the process of identification. Detailed lists of identified insects of the present study are in table 1 & **Appendix I**.

Table 1. Identified insects of various groups

Insects Orders	Families	Species	
		Identified	Unidentified
1. Coleoptera	7	18	-
2. Lepidoptera	9	10	45
3. Diptera	3	4	24
4. Odonata	2	-	2
5. Hymenoptera	5	6	
6. Orthoptera	1	-	2
7. Plecoptera	1	-	2
Total	28	38	75

5.6 The Future Plan

Due to paucity of time the insect surveys in Ladakh were limited in extent. It is thus proposed to undertake the remaining insect survey of Zaskar/Suru Valley and Hemis valley during the month of July 2001.

Reference

- Khan, R. A. and Sahni, N. K. 1978.** Preliminary report on the survey of aquatic ecosystem of river Beas with special reference to insects. *Mem. Sch. Ent.* 6: 107-114.
- Kulshrestha, A. K. 1978.** Chironomidae (Diptera) of river Beas ecosystem. *Mem. Sch. Ent.* 6: 113-114.
- Maheshwari, G. 1989a.** Distributional pattern of high altitude Chironomidae (Diptera). St. John's College, *Science Spectra* 1(1): 131-137.
- Mani, M.S. 1954.** Entomological Survey of the Himalaya. Part I. Introduction and Description of Gall-midges and plant galls from Western Himalaya. *Agra Univ.J.Res. (Sci)*, 3(1): 13-42.
- Mani, M. S. 1962.** Introduction to High Altitude Entomology. London Methuen and Co. 305 pp.
- Mani, M. S. and Santokh Singh, 1955.** Entomological survey of Himalay. Part xiii. Second Entomological expedition to the northwest (Punjab) Himalaya. *Agra Univ. J. Res (Sci)*, 4 (Supp): 717-740.
- Mani, M. S. and Santokh Singh, 1962.** Entomological survey of Himalaya. Part XXVI. A Contribution to our knowledge of the geography of the high altitude insects of the nival zones from the northwest Himalaya. Part 1. *Journal, Bombay Natural Hist. Society*, VI. 58(2):387- 406.
- Singh, Santokh. 1983.** High Altitude Entomology and its Scope. *Proc.Workshp.High Alt.Ent & Wildl.Ecol. zool. Surv. India* : 87-101.
- Uniyal, V.P. and Mathur, P.K. 1998.** Diversity of Butterflies in Great Himalayan National Park, Western Himalaya, *Indian Journal of Forestry*. Vol.21 (2); 150-155.
- Uniyal V. P and Mathur P.K. 1999.** A study of the species diversity among selected insect groups. Forestry Research Education and Extension Project in the Great Himalayan National Park (FREEP-GHNP) Wildlife Institute of India, Dehra Dun (Technical Report).
- Uniyal,V.P.1999.** Yellow Swallowtail Butterfly *Papilo machanon* Lepidoptera: Papilionidae) from Great Himalayan National Park, Himachal Pradesh, *Ann. For.* 7 (2): 301-302.
- Uniyal, V. P., Mitra, A. and Mathur, P.K. 2000.** Dragonfly Fauna (Insecta: Odonata) in Great Himalayan National Park, *Ann.For.* 8 (1): 116-119.
- Uniyal, V. P. and Mathur, P. K. 2001.** Altitudinal Distribution of Tiger Beetle (Cicindelidae: Coleoptera) from Great Himalayan National Park Conservation area. *Indian Forester*.Vol.162: 1141-1143.

Acknowledgements

I would like to express my sincere thanks the following individuals and organizations for their, advise, assistance during the survey and preparation of this report.

♦ *Forest & Wildlife Department Jammu & Kashmir*

Sh. Patnayak, Sh. R. K. Tiwari, Sh. Rauf Zatgar, Sh. S. A. Hydri, Mr. Abdul Rauf and Mr. Tsering Angchok.

♦ *Research Institutions and Universities*

Dr. Arun Kumar, Officer -In-Charge, Zoological Survey of India, Dehra Dun, Dr. Kailash Chandra, Officer-In-Charge, Zoological Survey of India, Jabalpur, Prof. H. S. Rose, Department of Zoology, Punjabi University, Patiala and Dr. Girish Maheshwari, St. John College Agra.

♦ *Field Research Laboratory (DRDO), 56 APO*

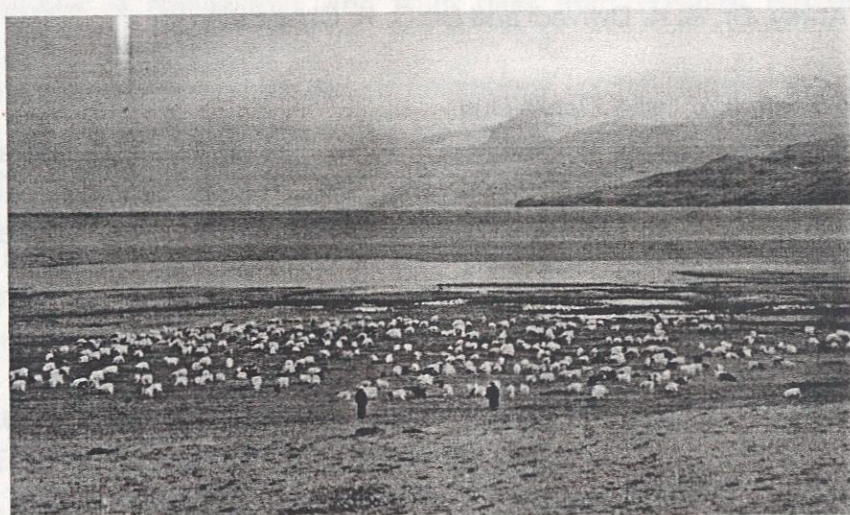
Col. D. P. Attrey, Dr. S. K. Dwivedi and Dr. O. P. Chousaria.

♦ *Wildlife Institute of India, Dehra Dun*

Sh. S. K. Mukherjee, Dr. V. B. Mathur, Dr. P. K. Mathur, Dr. G. S. Rawat, Sh. B. C. Choudhary, Dr. Qamar Qureshi, Sh. Pratap Singh, Dr. S. Sathyakumar, Dr. R. S. Chaundawat, Dr. S. A. Hussain, Dr. Yasveer Bhatnagar, Dr. B. S. Adhikari, Dr. C. P. Kala, Sh. Rakesh Singh, Sh. Raja Jaipal and Sh. K. Shivkumar



Parnassius epaphus (Common Red Apollo)



Wetland and Grazing Pasture



Colias cocandica (Clouded Yellow)

List of identified insect species of the study area

Insect Orders	Family	Species	Location	Habitat	Altitude (m)
1. Coleoptera	Scarabaeidae	<i>Melolontha bifuricaudata</i>	Diskit	Agriculture field	3,000 – 3,200
		<i>Pentodon</i> sp.	Lamayuru	*Light Trap	
		<i>Onthophagus</i> sp.			
		<i>Brahmina</i> sp.			
	ii. Coccinellidae	<i>Adoretus</i> sp.			2,800 - 3,200
		<i>Adalia decapunctata</i>	Leh	Agriculture field	
		<i>Adalia bipunctata</i>	Kargil		
Lepidoptera (Butterflies)	iii. Carabidae	<i>Coccinella septempunctata</i>	Drass		3,200 - 4,500
		<i>Bembidion ladas</i>	Tso-Moriri	Marsh vegetation	
		<i>Bembidion</i> sp.	Tsokar	Light trap	
		<i>Amara</i> sp.	Nyoma	Ground vegetation	
	iv. Curculionidae	<i>Achlaenomus babaulti</i>	Diskit, Leh		3,200 – 3,500
		<i>Legenolobus</i> sp.	Leh	Ground vegetation	
		<i>Scepticus</i> sp.	Diskit		
		<i>Melanotus</i> sp.			
	v. Elateridae	<i>Leptosonyx</i> sp.	Leh	Agriculture field Light trap	3,500
		<i>Merista</i> sp.	Leh	Ground vegetation	3,500
	vi. Chrysomelidae	<i>Atheta</i> sp.	Panamic	Light trap	3,200
		<i>Parnassius charltonius</i>	Diskit	Ground vegetation	
		<i>Parnassius epaphus</i>	Lamayuru	Flowers and Ground vegetation	
		<i>Parnassius simo zaraensis</i>	Khardungla		
	ii. Pieridae	<i>Papilio machaon ladakensis</i>	Khalsar		2,800 – 4,600
		<i>Pieris glauconome</i>	Leh	Agriculture field	
		<i>Pieris brassicae</i>	Drass	Ground vegetation	
		<i>Colias cocandica</i>	Tsokar		
Moths	iii. Nymphalidae	<i>Colias</i> sp.	Kargil	Ground vegetation	3,200
		<i>Vanessa ladakensis Danus</i> sp.	Diskit		3,500
	iv. Geometridone	5 sp. (to be identified)	Leh	Light trap	
		2 sp. (to be identified)	Diskit	Light trap	
	vi. Sphingidae	1 sp. (to be identified)	Nyoma	Light trap	4,200

Insect Orders	Family	Species	Location	Habitat	Altitude (m)
	vii. Pyralidae	1 sp. (to be identified)	Drass	Light trap	3,200
	viii. Pterophoridae	1 sp. (to be identified)	Kargil	Light trap	2,800
	ix. Noctuidae	35 sp. (to be identified)	Leh	Light trap	3,500
Diptera	i. Ephydriidae	<i>Ephydra glauca</i>	Tsokar	Marsh vegetation	4,600
	ii. Chironomidae	<i>Micropsectra glacies</i> <i>Micropsectra himachali</i> <i>Agromyza</i> sp.	Tso-Moriri	Marsh vegetation	4,500
	iii. Muscoidae	2 sp. (to be identified)	Diskit	Ground vegetation	3,200
Odonata	i. Coenagriidae	1 sp. (to be identified)	Panamic	Lake side	3,500
	ii. Libellulidae	1 sp. (to be identified)	Panamic	Lake side	3,500
Hymenoptera	i. Andrenidae	<i>Andrena</i> sp.	Hunder	Ground vegetation	3,200
	ii. Vespidae	<i>Vespa</i> sp.	Diskit	Ground vegetation	3,200
	iii. Bombidae	<i>Bombus</i> sp.	Lamayuru	Ground vegetation	3,500
	iv. Xylcopidae	<i>Xylcopis</i> sp.	Lamayuru	Ground vegetation	3,500
	v. Formicidae	<i>Camponotus</i> sp. <i>Formica</i> sp.	Leh Diskit	Ground vegetation	3,200 – 3,500
Orthoptera	i. Acrididae	2 sp. (to be identified)	Tsokar	Ground vegetation	4,600
Plecoptera	---	(to be identified)	Leh	Light trap	3,500

*Light Trap were used near the agricultural fields

Chapter 6

A Preliminary Survey of Herpetofauna in the Ladakh Region

by S.P. Vijaykumar with Karthik Vasudevan & B.C. Choudhary

6.1 Introduction

The Trans-Himalayas is poor in floral and faunal species richness compared to other regions in the Himalayas (Das, 1966). However, the Ladakh region is represented by an array of unique species adapted to the 'cold desert' conditions. The region being situated in the junction of Palearctic and Oriental biogeographic realms, the faunal and floral communities are composed of species contributed from these zones (Das, 1966). Hence, Ladakh assumes importance in conservation of its floral and faunal assemblages. There have been few studies in the past, which have documented the faunal diversity of this vast landscape, and herpetofaunal diversity in particular has received little attention. Important contributions on the herpetofauna of this region came during the early part of this century through compilations by Smith (1934) and Boulenger (1890). After a lapse of several decades, herpetofaunal surveys were initiated in the Jammu and Kashmir State (Sahi and Duda, 1985, 1986). Subsequently some observations on the herpetofauna have been published (see Sahi and Duda, 1986; Verma and Sahi, 1995, Sahi *et al.*, 1996). The information on the surveys conducted so far have been from specimens collected from only the Indus valley, that too along the Leh – Srinagar highway. It was felt that the remaining regions of Ladakh such as Suru, Zaskar, Changthang and Nubra valleys had to be surveyed to provide a comprehensive baseline information on the herpetofaunal diversity in the region. The present survey was carried out with the following objectives.

1. To survey the amphibian and reptilian species in the Ladakh region
2. To assess the distribution of species
3. To standardize methodology for research and monitoring.

6.2 Study Area

Five major landscape units were chosen for this study; Indus Valley, Suru Valley, Zaskar Valley, Changthang Plateau and Nubra Valley. Within the landscape units, a number of sites were surveyed for amphibians and reptiles (See Figure 1, Table 1). All the landscape units except Changthang plateau were characterized by river valleys with steep mountains and high pass. These valleys broaden at many sites as seen in Leh, Nubra, Rangdum and Padum. In many localities, the valleys changed into undulating plateaus as seen in Khaltse and Suru. Survey localities varied in altitude from 2900m to 4600m asl. Many sites were inhabited by humans and consisted of extensive agricultural fields. In contrast to these valley

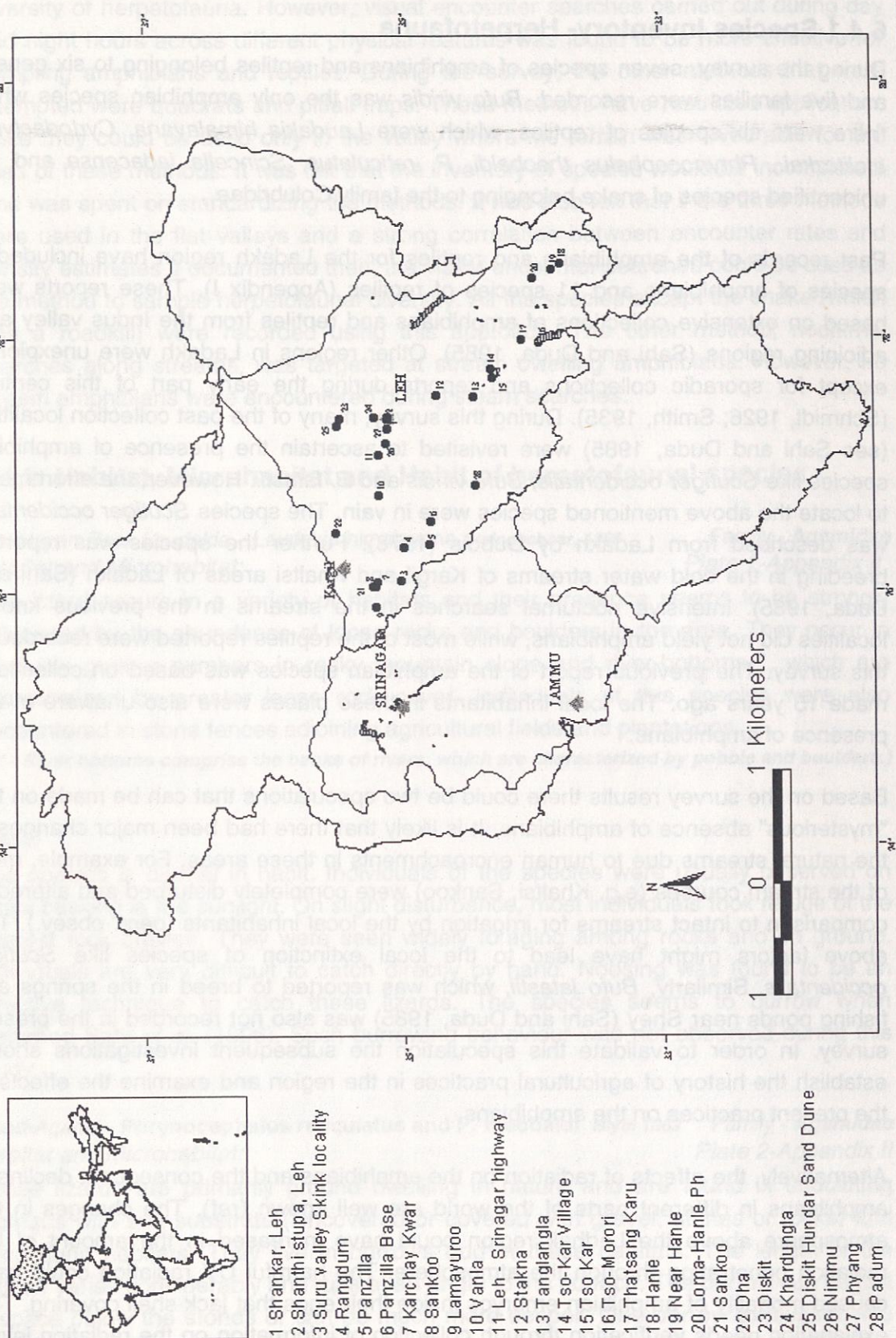
landscapes, extensive tablelands (above 4000m asl) bordered by low and flat-topped mountains characterized the Changthang plateau. This area was also unique in having many high altitude lakes and wetlands contiguous with the Tibetan plateau. Hence, it topographically resembles the Tibetan plateau in many ways. It is also sparsely populated in contrast to the river valley landscapes of Leh. The highest sampling site in this region was 4700m asl at Thatsang Karu.

Seasonality was highly pronounced in Ladakh, with short pronounced summer during the months of July and August. All other months except four months between May to August were cold with heavy snow cover. Rainfall is very minimal with an average annual rainfall of less than 100mm (see Gupta, 1994). The above figures are for Leh area, and one can expect variations based on altitude and relief in the adjoining areas.

3 Methods

The study was carried out between June 15th 2000 and August 15th 2000. The survey period coincides the peak activity season for amphibians and reptiles. In an attempt to cover a large portion of the Ladakh region, we compromised on the type of data that was collected during the study. We followed *ad libitum* observations without any systematic sampling. Hence the objective of standardizing methods for sampling amphibians and reptiles was not addressed. Most of the information collected was qualitative in nature. The sampling methods included 1) general visual searches across different physical features and 2) Nocturnal searches along streams. The general visual search was carried out both during day and night at different time periods. For each individual encountered, the following information was collected; Habitat, microhabitat, altitude, GPS location. Nocturnal stream searches was carried along stream courses between 21:00 and 24: 00 hrs. This method was aimed at stream dwelling amphibians. All the species encountered, except the road killed snake were photodocumented.

Figure 1. Location of sites surveyed for amphibians and reptiles in the Ladakh region



6.4 Results and Discussion

6.4.1 Species Inventory- Herpetofauna

During the survey, seven species of amphibians and reptiles belonging to six genera and five families were recorded. *Bufo viridis* was the only amphibian species while there were six species of reptiles, which were *Laudakia himalayana*, *Cyrtodactylus stoliczkai*, *Phrynocephalus theobaldi*, *P. reticulatus*, *Scincella ladacense* and an unidentified species of snake belonging to the family Colubridae.

Past records of the amphibians and reptiles for the Ladakh region have included 3 species of amphibians and 11 species of reptiles (Appendix I). These reports were based on extensive collections of amphibians and reptiles from the Indus valley and adjoining regions (Sahi and Duda, 1985). Other regions in Ladakh were unexplored except for sporadic collections and reports during the early part of this century (Schmidt, 1926; Smith, 1935). During this survey, many of the past collection localities (see Sahi and Duda, 1985) were revisited to ascertain the presence of amphibian species like *Scutiger occidentalis*, *Bufo viridis* and *B. latastii*. However, the effort made to locate the above mentioned species were in vain. The species *Scutiger occidentalis* was described from Ladakh by Dubois (1978). Further the species was reported breeding in the cold water streams of Kargil and Khaltai areas of Ladakh (Sahi and Duda, 1985). Intensive nocturnal searches in the streams in the previous known localities did not yield amphibians, while most of the reptiles reported were recorded in this survey. The previous report of the amphibian species was based on collections made 15 years ago. The local inhabitants in these places were also unaware of the presence of amphibians.

Based on the survey results there could be two speculations that can be made on the "mysterious" absence of amphibians. It is likely that there had been major changes in the natural streams due to human encroachments in these areas. For example, most of the stream courses (e.g. Khaltai, Sankoo) were completely disturbed and altered in comparison to intact streams for irrigation by the local inhabitants (pers. observ.). The above factors might have lead to the local extinction of species like *Scutiger occidentalis*. Similarly, *Bufo latastii*, which was reported to breed in the springs and fishing ponds near Shey (Sahi and Duda, 1985) was also not recorded in the present survey. In order to validate this speculation the subsequent investigations should establish the history of agricultural practices in the region and examine the effects of the present practices on the amphibians.

Alternatively, the effects of radiation on the amphibians and the consequent decline in amphibians in different parts of the world are well known (ref). The changes in the atmosphere above the Ladhak region could have increased in the amount of UV radiation penetrating through the atmosphere. The harmful UV radiation could have caused mortality of amphibian embryos inside their eggs that lack shell covering. This explanation needs verification through collection of information on the radiation levels in the Ladhak region over the last 15 years and confirmation of the potency of radiation to cause mortality of amphibians.

The survey did not use any specific method to enumerate the abundance or the diversity of herpetofauna. However, visual encounter searches carried out during day and night hours across different physical features was found to be more effective for sampling amphibians and reptiles. During the survey, the other methods that were attempted were quadrats and pitfall traps. These methods have restricted application, since they could be used only in the valley where the terrain was favourable for the uses of these methods. It was felt that the inventory of species would be incomplete if time was spent on standardizing the methods. It was also felt that if the three methods were used in the flat valleys and a strong correlation between encounter rates and density estimates if documented then, the visual encounter searches could be used as the method to sample herpetofaunal diversity. All the species except the snake (which was a roadkill) were recorded using this approach. The other method, nocturnal searches along streams, was targeted at stream dwelling amphibians. However, no stream amphibians were encountered during steam searches.

6.4.2 Habitat, Microhabitat and Habit of herpetofaunal species

Himalayan Rock Laudakia – *Laudakia himalayana* Steindachner, 1869

Family - **Agamidae**

Habitat and Microhabitat:

Plate 1-Appendix II

This lizard occurs in a variety of habitats and their presence seems to be strongly influenced by the abundance of loose rocks and boulders in the area. They occur in relatively greater numbers in rocky mountain slope and river-bottoms *, which are characterized by greater loose rock cover. Individuals of this species were also encountered in stone fences adjoining agricultural fields and plantations.

(* - River bottoms comprise the banks of rivers, which are characterized by pebble and boulders.)

Habit:

The species is diurnal in habit. Individuals of the species were usually observed on rocks basking in the sunlight. On slight disturbance, most individuals took refuge of the nearest rock crevice. They were seen widely foraging among rocks and on ground. Individuals are very difficult to catch directly by hand. Noosing was found to be an effective technique to catch these lizards. The species seems to burrow when disturbed Sahi *et al.* (1996). Such burrowing behaviour was not observed during this study.

Toad-Agama - *Phrynocephalus reticulatus* and *P. theobaldi* Blyth 1863

Family - **Agamidae**

Habitat and Microhabitat:

Plate 2-Appendix II

These lizards are primarily ground dwelling in nature and are found in undulating plateaus with soft substrate (Uncovered or covered with gravel, stones or rocks) and sand dune habitats. They live in burrows dug in these habitats. The length of the burrow varies considerably and runs at an angle to the surface. The burrow can be just a space below the stones or can be much more deeper. One burrow excavated was approximately 32cm in depth. The entrance to the burrows is usually oval in shape.

Habit:

The species is diurnal in habit. Individuals were observed basking on small stones and on the ground (in areas lacking stones). When approached, they take refuge in the burrow. Individuals run very fast, sometimes covering long distance before taking refuge in the burrows. The individuals have a prehensile black tipped tail, which they use for intra-specific signalling (Arnold, 1998). Sahi et al. (1996) had remarked on the escape behaviour of this species as "at the sight of any danger, the lizard burrows itself quickly (sand swimming) under the ground". No such behaviour was observed during the survey. The observations of Sahi et al (1996) is questionable, since most of the areas except sand dunes, the ground is semi- hard making it impossible for any species to burrow immediately. Indeed, they live in burrows dug by them and even in Sand dune areas, the species was observed using burrows dug by them and took refuge in it, when approached. Similar observations were made by Smith (1935). He also pointed out the monogamous nature of this species, which we were unable to verify. During the course of the survey, we never observed individuals of this species in pairs as observed by Smith (1935).

Bent-toed gecko - *Cyrtodactylus stoliczkai*

Family - Geckonidae

Habitat and Microhabitat

Plate 3-Appendix II

The species occurs in a habitat similar to that of *Laudakia himalayana*. Individuals were observed on the lower rocky mountain slopes. Most individuals were caught under stones and rocks in this habitat. No individual of this gecko was found active during the daytime. Few individuals of this species were found on mud walls and floor in human habitations during night hours.

Habit

The species is nocturnal in habit. During daytime individuals were seen under rocks, usually on the ground. Individuals were darker in color when under rocks and when moved into light conditions, they turned pale, making the body patterns distinct. Two forms of individuals were observed; tapering tail form and bulged tail form. The bulged portions are probably regenerated tail tips of the individuals, following autotomy.

Skink - *Scincella ladacense*

Family - Scincidae

Habitat and Microhabitat

The species were recorded only from river bottoms and adjoining mountain slopes in Suru valley. Their numbers were very high in the river bottom habitat. The river bottom sampled in Rangdum area is covered with large and small sheet rocks, fragments from the hilltop. These sheet rocks acts as good cover and microhabitat for this species.

Habit

The species is diurnal in habit. Individuals were observed basking on sheet rock faces in the river bottom. They are good at maneuvering among crevices and stones even in steep rock faces. Many individuals were observed close to water and some were even sighted in moist areas under rocks. The species unlike other reptiles seems to prefer moist areas. They are also highly agile and were very difficult to capture. When disturbed they immediately took refuge under sheet rocks.

European Green Toad - Bufo viridis

Family - Bufonidae

Habitat and Microhabitat

Plate 4-Appendix II

This species was observed in manmade water ponds, along irrigation channels, agricultural fields, and inundated areas adjoining rivers. Tadpoles were observed only in stagnant ponds with in agricultural fields adjoining river bottom areas. A total of 48 individuals were observed during nocturnal searches over a period of six days. Individuals were found in close proximity to watercourses both disturbed and undisturbed.

Habit

The species is Nocturnal in habit. At night hours, individuals can be seen along ponds and water channels. Many individuals were observed half-submerged in ponds. They are good swimmers, and when disturbed submerge in water and remain motionless in the bottom for many seconds. In contrast to the adults, tadpoles were usually inactive during night hours and are diurnal in habits. Shoals of tadpoles could be seen along pond edges during night hours.

Unidentified Snake

Family - Colubridae

One individual was collected as a road kill in the Saspol village. The adjoining roadside habitat was of agricultural fields.

6.4.3 Species Distribution in Ladakh

Collections were made at different altitudes ranging between 2900 and 4800-m amsl. During the current survey, altitudinal data were collected for five species. All the five species were present between 2700 and 4000 m (Fig 2). Only two species, Phrynocephalus theobaldi and Scincilla ladascence occurred above 4000 m altitude. P. theobaldi, was observed unto 4795m. The species occurs up to approx. 5500m in the Tibetan region (Smith, 1935). The highest altitude recorded for Laudakia himalayana was 3700 m. This species is known to occur up to approx. 3550 m (Smith, 1935).

Laudakia himalayana and Phrynocephalus theobaldi are two widely distributed species in the Ladakh region. This species was not observed above 3700m (approx.). L. himalayana, seems to be restricted by altitude. The global distribution of species ranges from the Eastern Turkestan, North - West Frontier Province to Western Tibet (Smith, 1935).

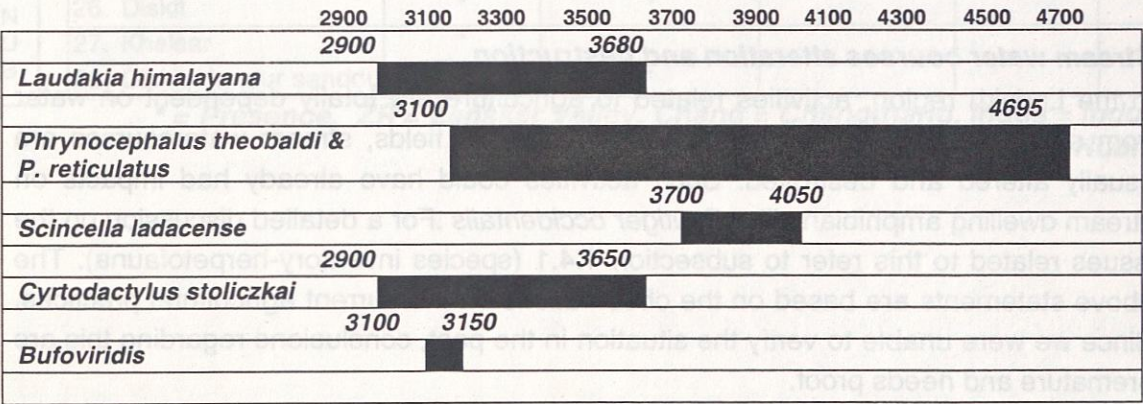


Fig.2 Altitudinal range of herpetofauna in Ladakh based on the current survey

The abundance of *Phrynocephalus theobaldi* and *P. reticulatus* was greater in the Changthang area, a region characterized by more flat and undulating plateaus. The two species of *Phrynocephalus* probably have exclusive altitudinal distribution. *Cyrtodactylus stoliczkae* was observed in many localities in the Indus valley and in one locality in the Suru Valley. The *Scincella ladacense* was recorded only in the Suru valley. Skinks have been reported from many areas of Ladakh including parts of Hemis N.P., Pongong Tso (Dr. Yash Veer Bhatnagar, *Pers. Com.*). The only amphibian species recorded during the study was restricted to the Suru valley. The species was encountered in three villages in this valley. Based on information from local people, the species also occurs in many villages along the Suru valley between Minchi and Panikhar Village. Snakes are usually rare in the Ladakh region. The only species recorded was a roadkill from the Saspol village (alt. 3280m) in the Indus valley. According to the local people snakes are likely to be found in the following localities; Minchi (Suru valley), Khalatse, Dha (Indus Valley), Chillung (Zaskar valley). Both reptiles and amphibians were not observed in the Zaskar valley (refer to Table 1). The failure to encounter any reptiles or amphibians could be due to the less time spent in surveying this valley.

6.4.4 Probable Threats

In the following paragraph an account of the possible threats faced by the amphibians and reptiles is provided. The information is based both on direct observations and speculation and no attempt has been made to evaluate the magnitude of the effects.

Vehicular traffic

All the species except *Laudakia himalayana* were encountered as roadkills, which indicates the vulnerability of many of these species to vehicular traffic. The major threat seems to be from the off-road vehicles especially in undulating and flat areas. Due to the nature of the terrain many people tend to take their vehicles off-road, which is likely to cause a great damage to species like *Phrynocephalus theobaldi*, a ground dwelling lizard living in burrows dug by them. Areas in and around Tso-kar lake in fact do not have proper roads, making the situation much worse. These areas also hold the highest density of *P. theobaldi*, making them highly vulnerable to traffic. Conservation initiatives should focus at minimizing such off-road vehicles.

Stream water courses alteration and destruction

In the Ladakh region, activities related to agriculture are totally dependent on water from streams and rivers. In attempts to irrigate the fields, stream watercourses are usually altered and destroyed. Such activities could have already had impacts on stream dwelling amphibians like *Scutiger occidentalis*. For a detailed discussion on the issues related to this refer to subsection 1.4.1 (species inventory-herpetofauna). The above statements are based on the observations on the current agricultural practices. Since we were unable to verify the situation in the past, conclusions regarding this are premature and needs proof.

Afforestation and Landscape conversion

The Ladakh region naturally has sparse tree and ground cover. Hence any attempts to re-vegetate the areas (which the forest department is trying to do) and other related activities like irrigation is likely to have an adverse impact on the species which are adapted to these arid conditions. Unique habitats like Sand dunes (Nubra valley) are also under immense danger due to encroachment from forest department plantations, which should be judicially decided after a possible impact assessment study.

Table 1. Records for herpetofaunal species sightings in Ladakh

	Locality/Species	<i>Laudakia himalayana</i>	<i>Phrynocephalus theobaldi</i> , <i>P. reticulatus</i>	<i>Cyrtodactylus stoliczkai</i>	<i>Scincella ladacense</i>	<i>Bufo viridis</i>	Colubrid
INDUS	1. Leh-Shankar	*	*	*			
	2. Leh-Shanthistupa	*	*	*			
	3. Phyang	*	*				
	4. Leh-Kargil Highway	*	*				
	5. Khalste	*		*			
	6. Dha	*					
	7. Lamayuru			*			
	8. Stakna	*	*				
	9. Upshi	*					
	10. Upshi-Mahe road	*					
	11. Saspol						*
SURU	12. Kargil-Sankoo Road	*		*			
	13. Sankoo	*				*	
	14. Karchaykwar	*				*	
	15. Thasgam					*	
	16. Suru skink				*		
	17. Rangdum				*		
	18. Panzilla Base						
ZR	19. Padum						
	20. Padum pleateau						
	21. Tso Kar		*				
CHANG	22. Tso Morori		*				
	23. Thatsang Karu		*				
	24. Loma-Hanle road		*				
	25. Hanle		*				
NUB	26. Diskit	*	*				
	27. Khalsar	*					
	28. Diskit-Hundur sanddunes		*				

* = Presence, ZR = Zaskar Valley, Chang = Changthang, Indus = Indus Valley, Suru = Suru Valley, Nub - Nubra

6.4.5 Miscellaneous Notes

Lizards are one of the well-known groups among the local human communities. Among lizards, *Laudakia himalayana* is widely known across different areas. Most people expressed their fear over these animals. They usually kill the male of *Laudakia himalayana*. Females are locally known as Llama lizard. This is probably because of the bright yellowish orange colored patches on females (neck side). Many people in Ladakh were unaware of the frogs, except in parts of Suru valley. Like lizards frogs are also highly feared. A list of Local names for amphibians and reptiles is given in the **Table 2**.

Table 2. Vernacular Names for Amphibians and Reptiles

English	Ladakhi
Frog	Balpa or Sbalpa
Tadpole	Xerbhuldhux
Snake	Rhul or Sbul
Lizard (<i>Laudakia</i>)	Galchik or Llama galchik
Gecko	Saldak
Skink	Galto

References

- Arnold, E. N. (1999).** Phylogentic relationships of toad-headed lizards (*Phrynocephalus*, Agamidae) based on morphology. *Bull. Nat. Hist. Mus. Lond. Zool.* 65(1): 1-13.
- Boulenger, G. A. (1890).** The fauna of British India including Ceylon and Burma. Reptilia and Batrachia. London.
- Das, S. M. (1966).** Palaearctic elements in the fauna of Kashmir. *Nature.* 212. 1327 – 1330.
- Dubois, A. (1978).** Une espece nouvelle de Scutiger Thebald 1868 de l' Himalaya Occidental (Anura : Pelobatidae) . *Senckeubergiana Biol.* 59 (3-4): 163 – 171.
- Gupta, R.K. (1994).** Resource ecology for soil conservation and sustainable development in the cold desert regions of Western himalayas. *In* eds. Pangtey & R.S.Rawal High altitudes of the himalayas (Biogeography, Ecology and Conservation). 139 - 177.
- Sahi, D. N. and Duda, P. L. (1985).** A checklist and keys to the amphibians and reptiles of Jammu and Kashmir State, India. *Bulletin Chicago herpetological society.* 20 (3-4). 86 – 97.
- Sahi, D. N. and Duda, P. L. (1986).** Affinities and distribution of amphibians and reptiles of Jammu and Kashmir state. *Bulletin Chicago herpetological society.* 21 (3-4). 84 – 88.
- Sahi, D. N., Abrol, B., Verma, A. K. (1996).** Ecological notes on the herpetofauna of Ladakh region in J & K state. *Cobra.* 26. 1 – 10.
- Schmidt, K. P. (1926).** Amphibians and reptiles of the James Simpson – Roosevelt Asiatic expedition. *Field Museum of Natural History- Zoology series.* Vol. XII (13). 167 – 173.
- Smith, M.A. (1935).** The fauna of British India, including Ceylon and Burma. Reptilian and amphibian. Vol. 2, Sauria. London : Taylor & Francis.
- Verma, A. K. and Sahi, D. N. (1995).** The amphibian fauna of Jammu and Kashmir state. *Cobra.* 20. 2 – 6.
- Waltner, R. C. (1974).** Amphibians and reptiles in the Himalayas. *Cheetal.* 17 – 25, 28 – 36, 14 – 19, 13 – 17.

List of amphibians and reptiles reported in the Ladakh region

(Source: *Sahi et al., 1996; %Smith, 1935)

Amphibians

Family Bufonidae*

*Bufo viridis***Bufo latastii***Scutiger occidentalis****Reptiles**

Family Agamidae

Phrynocephalus theobaldi%*Phrynocephalus reticulatus*%*Laudakia himalayana**

Family Geckonidae

*Cyrtodactylus montium salsorum***Cyrtodactylus stoliczkaei*%*Cyrtodactylus lawderanus**

Family Scincidae

*Scincella himalayana** (*Eumeces himalayanus*)*Scincella ladacense* % (*Eumeces ladacense*)

Family Colubridae

*Coluber rhodorachis***Elaphe hodgsoni***Ptyas mucosus**

7.2 Ladakh: Biophysical Features

7.2.1 Location

Ladakh is located in the northernmost state of India, in Jammu and Kashmir between 32°15' to 36° N and 75°15' to 80° 15' E. It covers an area of approximately 58,000 sq. km. It is bounded in the north by the eastern range of Karakoram Mountains, to the south by the western extreme of the main Himalaya, the Tibetan Plateau above the north-eastern tablelands of Ladakh. The highest peak is Saser Kangri (7,680 m) that towers from an outlying spur of the range between the upper reaches of the Shyok and Nubra rivers. The summit of the Zaskar range is in the region of 5,500 to 6,200 m. The altitude, in general, ranges from c. 3000 m (lower Indus and Nubra valleys) to 7500 m (Zaskar and Karakoram ranges). The monotonously barren mountain landscape is broken by a host of small to large rivers, notably the Indus (which runs

A Survey of Breeding Birds of Ladakh

by Pratap Singh & R. Jaypal

7.1 Introduction

The Himalayas constitute arguably one of the richest and most unique ecosystems on earth's biosphere, with two of the subcontinent's ten major biogeographical zones stretching exclusively along the ranges: i. Trans-Himalaya and ii. Main Himalayas (Rodgers & Panwar, 1988). Of these two, the Trans-Himalaya is a systemically fragile biome, characterized by extremes of both climatic and biotic factors; very low productivity and a high degree of resource seasonality and unpredictability give rise to a unique diversity of life that is persistently prone to any kind of disturbance. Ladakh, in north-western India, represents almost the entire Trans-Himalayan zone with a vast area of about 186, 200 sq. km. Lying in the rain shadow region of the Himalayas, it receives very little precipitation (< 100 mm p.a) and forms a high altitude cold desert. The wild flora and fauna of this cold desert have long past adapted themselves to such extreme conditions and their essentially low population abundance is one of such evolutionary responses.

Though Ladakh boasts of distinct assemblage of high altitude flora and fauna, it still remains the least protected ecosystem with only one national park, viz., Hemis NP covering Rumbak and Markha valleys. To protect the biodiversity of Ladakh, three protected areas viz., Hemis National Park (c.a 4100 km²), Karakoram Wildlife Sanctuary (ca. 5000 km²) and Changthang Wildlife Sanctuary (c.a 4000 km²), have been notified so far. There are also five wildlife reserves (Randum, Sabu-Chakur, Rizong Basgo, Gya-Miru and Kangri) and three game reserves (Bodh Karbu, Tongri and Lung lang) in Ladakh (Rodgers & Panwar, 1998).

7.2 Ladakh: Biophysical Features

7.2.1 Location

Ladakh is located in the northernmost state of India, in Jammu and Kashmir between 32°15' to 36° N and 75°15' to 80° 15' E. It covers an area of approximately 98,000 sq. km. It is bounded in the north by the eastern range of Karakoram Mountains, to the south by the western extreme of the main Himalaya; the Tibetan Plateau abuts the north-eastern tablelands of Ladakh. The highest peak is Saser Kangri (7,680 m) that towers from an outlying spur of the range between the upper reaches of the Shyok and Nubra rivers. The summit of the Zaskar range is in the region of 5,500 to 6,200 m. The altitude, in general, ranges from c. 3000 m (lower Indus and Nubra valleys) to 7600 m (Zaskar and Karakoram ranges). The monotonously barren mountain landscape is broken by a host of small to large rivers, notably the Indus (which runs

through Ladakh from south-west to north-east) and its tributaries like Zaskar, Markha, Shyok, Nubra, and Suru (cutting across in north-south or south-north directions meeting the mid-rib of Indus). The river valleys are characterized by riverbed vegetation communities mostly dominated by *Hippophae* sp., *Myricaria* sp., and *Caragana* sp. Of late, large scale plantations of dwarf willow (*Salix* sp.) have been raised along the stretch of river valleys. Siachen, the world's largest glacier, is located towards the northwestern part of Ladakh.

7.2.2 Geology and Soil

Ladakh is wholly mountainous in character that is composed of continuous series of highly fossiliferous marine sedimentary rocks, ranging in age from the earliest Palaeozoic to the Eocene (Kachroo *et al.*, 1977). The terrain is extremely rugged with a high proportion of cliffs, screes and exposed rocks. Gently sloping alluvial fans form a short section of stone desert along both the south and north banks of the Indus river. Eastern Ladakh after Taglang-la forms an extensive plateau. In eastern Ladakh, the proposed Gya-Miru Wildlife Sanctuary and its adjacent areas are marked with a rock composition of slate, phyllite, schist, quartzite, crystalline limestone, and dolomite (Mallon, 1989). The soils of Ladakh have been classified as grey, light, and arid, and are characterised by low fertility and a scanty vegetation cover. The soils, for most part of Ladakh, are sandy clay and, to a lesser extent, loam or loamy clay (Kachroo *et al.*, 1977).

7.2.3 Climate

Climatically, Ladakh is extremely cold during winter when temperature goes down at places to minus 30 to 40 degree celsius. It does not have much rain or snowfall. Annual precipitation decreases to the north and east, ranging from 500-1,000 mm in valleys just north of the main Himalaya to approximately 100 mm in the central Trans-Himalayan valleys such as the upper Indus near Leh (Fox *et al.* 1994). In general, the south-western Ladakh comprising of Zaskar and Suru valleys receive more precipitation than the rest; such a moisture gradient from west to east is strongly reflected by a corresponding change in abundance and composition of avifauna.

7.2.4 Flora

Plant species of Ladakh are mostly xerophytes followed by mesophytes (Chaurasia & Singh, 1996). Kachroo *et al.* (1977) collected 611 plant species from different parts of Ladakh, out of which 540 species were dicots, 65 monocots and 2 the gymnosperms.

In general, annual and perennial herbs followed by few dwarf shrubs dominate the flora of Ladakh. In the different zones of Ladakh, vegetation changes gradually from primarily alpine meadow (*Carex*, *Potentilla*, *Nepeta*) on the north side of the Himalayan crest to steppe vegetation (*Caragana*, *Artemisia*, *Stachys*, *Ephedra*, *Stipa*) to the north and east, with shrublands (*Hippophae*, *Salix*, *Myricaria*) along the river courses (Kachroo *et al.*, 1977). The region is virtually treeless, except for cultivated varieties of poplar and willow species along the major water courses. Apparently juniper and birch have disappeared from many areas within historical times and only a few relict stands still survive in some of the more remote river gorges (Fox *et al.*, 1994).

7.2.5 Birds

Birdlife of Ladakh is characterized by a marked seasonal variation with summer visitors that breed in Ladakh (about 110 species) and winter at lower altitudes to plains, and winter visitors from central Asia and northern Tibetan Plateau. A total of 225 species have been reported from the entire Ladakh region (Chundawat & Rawat, 1994; Pfister, 1997), represented by 34 families. However, local altitudinal movements, breeding status, and distribution limits of many avian species are little-known as very few studies have been taken up in the past. The only old publications included Osmaston (1925), Ludlow (1920), Wathen (1923), and LaPersonne (1928), apart from A. E. Ward's series on birds and mammals of Jammu & Kashmir in JBNHS (1906-1928); recently, Holmes (1986), Mallon (1987), and Pfister (1997) conducted general bird surveys. The ecology of Black-necked Crane was quite extensively studied in late eighties and nineties (Narayan et al., 1987; Gole, 1992; Pfister, 1998).

The avifauna of Ladakh includes some restricted-range species of conservation significance; these species show little altitudinal movement and form flagship community (the nomenclature and classification follow Grimmett et al., 1998):

- i. Tibetan Snowcock (*Tetraogallus tibetanus*)
- ii. Tibetan Partridge (*Perdix hodgsoniae*)
- iii. Little Owl (*Athene noctua*)
- iv. Black-necked Crane (*Grus nigricollis*)
- v. Tibetan Sandgrouse (*Syrrhaptes tibetanus*)
- vi. Desert Wheatear (*Oenanthe deserti deserti*)
- vii. Tibetan Lark (*Melanocorypha maxima*)
- viii. Hume's Short-toed Lark (*Calandrella acutirostris*)
- ix. Horned Lark (*Eremophila alpestris*)
- x. Tibetan Snowfinch (*Montifringilla adamsi*)
- xi. Plain-backed Snowfinch (*Montifringilla blanfordi*)
- xii. Brandt's Mountain Finch (*Leucosticte brandti*)

Apart from these endemic taxa, many birds breed selectively in Ladakh and move down to peninsular India in winter. A regular, seasonal monitoring of these populations is imperative for conservation planning as they can serve as indicators of ecosystem health over years; such species include anatids (*Anas acuta*, *Mergus merganser*), sandpipers (*Tringa ochropus*, *Tringa totanus*), sandpipers (*Charadrius mongolus*), gulls & terns (*Larus ichthyaetus*, *Larus brunnicephalus*, *Sterna hirundo*), raptors (*Accipiter nisus*, *Buteo rufinus*, *Falco tinnunculus*), bluethroats (*Luscinia svecica*), leaf warblers (*Phylloscopus trochiloides*, *P. griseolus*, *P. sindhianus*), wagtails (*Motacilla* spp.), and rosefinches (*Carpodacus rubicilla*, *Carpodacus puniceus*).

It is also interesting to note the commensal species whose distribution is largely governed by human settlements and their economic activities. For example, opportunistic species like European Goldfinch (*Carduelis carduelis*) Great Tit (*Parus major*), Winter Wren (*Troglodytes troglodytes*), Oriental Turtle Dove (*Streptopelia*

orientalis), and Eurasian Sparrowhawk (*Accipiter nisus*) are strongly associated with old-growth poplar groves around villages. Farming in Ladakh is limited to only four summer months in a year; during this period inter-cultivation operations and harvesting attract huge congregations of granivorous birds like Hill Pigeons (*Columba rupestris*), wagtails (esp. *Motacilla alba*), rosefinches (*Carpodacus* spp.), buntings (*Emberiza* spp.), and serins (*Serinus pusillus*).

To fill the gap in our knowledge of the Ladakh ornithology, the Himalayan Biodiversity Project of WII has taken up an initiative for conducting bird surveys across seasons. As a part of it, an autumn survey (post-breeding) was carried out (by RJ) during September - October in 1999, and the results were reported in HBD Technical Report, 1998-99. It was decided to hold a summer survey, this year, to study the distribution patterns of the breeding birds of Ladakh.

7.3 Objectives

This short-term survey was taken up to meet the following objectives:

- ◆ To inventory the breeding species of Ladakh avifauna and assess their population status.
- ◆ To study their distribution in Ladakh with respect to different landscape units.
- ◆ To identify potential and current problems in the conservation of native birds of high-altitude cold deserts.

7.4 Study Area

Field work was conducted from 16th June to 14th July, 2000 in different parts of Ladakh including Zaskar, Indus valley, Chang Thang, and Rupshu Plateaus. Based on geomorphology, location, and climatology, we divided our survey area into six distinct units of Ladakh landscape, and the distribution of breeding birds were studied vis-à-vis these units. [See the Appendix:1, for geographical location of major survey sites and their lat.-long. data & altitude].

ZANSKAR: It includes both Upper Suru and Zaskar valleys, ranging from Panikhar (N 34° 06' 16.0"; E 75° 56' 49.5") to Padum (N 33° 28' 11.6"; E 76° 52' 45.7"). The altitude varies between 3400 m (Panikhar) and 4550 m (Penzi La). There are two large glaciers in the region: one just below the Nun-Kun peak, and another at the base of Penzi La. The landscape is characterized by extensive agriculture, and moist grazing pastures comprising of wet turf-grass country.

SURU VALLEY & WAKKA NALLAH STRETCH: It includes Lower Suru valley from Panikhar (N 34° 06' 16.0"; E 75° 56' 49.5") to Kargil, and Wakka Chu stretch from Kargil to Mulbek (N 34° 22' 45.2"; E 76° 22' 01.5"). The altitude varies similarly on both valleys: 2800 m (Kargil) to 3400 m (Panikhar), and 2800 m (Kargil) to 3430 m

(Mulbek). There are no passes in this region, and the dominant vegetation is *Hippophae* scrub. Being at the lower elevation, the birdlife is essentially dominated by opportunistic species like Grey Tits, European Goldfinches, and Hoopoes.

LOWER INDUS VALLEY: This extends along the Indus river from Leh (N 34° 10' 19.6"; E 77° 34' 42.4") to Lamayuru - Khaltse (N 34° 17' 25.1"; E 76° 47' 32.1"). The elevation, for most part, ranges from 3100 m (Khaltse) to 3500 m (Leh), though it goes high up to 4100 m at Fotu La, which is located a little beyond Indus valley. The valley is dotted, all along its stretch, with many villages and rolling agricultural fields; gentle undulating stony uplands that link the riverbed with barren mountains are a characteristic landscape feature of this valley. The vegetation is mainly dominated by *Hippophae* scrubs along the river.

UPPER INDUS VALLEY: The Indus stretch from Leh (N 34° 10' 19.6"; E 77° 34' 42.4") upwards to Nyoma (N 33° 12' 08.0"; E 78° 38' 59.9") through Mahe bridge constitutes the Upper Indus valley. The altitude varies between 3500 m (Leh) and 4200 m (Nyoma). The landscape is largely typified by rugged mountains, lying close to Indus.

CHANG THANG: This region lies south and east of Upper Indus valley, characterized by arid alpine pastures. The geographical extension of Chang Thang is: a) Hanle - Nyoma - Loma (from N 33° 12' 08.0"; E 78° 38' 59.9" to N 32° 47' 07.3"; E 79° 00' 14.7"), and b) Tso Moriri (Korzok) - Thatsang Karu - Sumdo - Mahe bridge (from N 32° 58' 09.9"; E 78° 16' 22.5" to N 33° 16' 09.3"; E 78° 28' 15.5"). The vegetation is dominated by *Caragana* bushes and grassy patches.

RUPSHU: It extends from Upshi (N 33° 49' 49.5"; E 77° 48' 58.0") southwards to Taglang La pass (N 33° 30' 31.7"; E 77° 46' 15.4") through Meru - Gya - Lato stretch, and then from Taglang La to Tso Kar Lake (N 33° 19' 52.7"; E 78° 02' 13.8"). The altitude varies from 3600 m (Upshi) to 5250 m (Taglang la). The landscape is very heterogeneous, from narrow mountain gorges of Meru - Lato stretch to snow-bound pass and to high-altitude tablelands adjacent to Tso Kar. The lake ecosystem of Tso-Kar consists of two parts: i) the sweet-water lake in the southern Tso-Kar plain, called 'Startsapuk-Tso', and ii) Tso-Kar, proper which is a large brackish-salt-water lake.

7.5 Materials & Methods of Survey

As the objective of the survey is to collect first-hand information on the distribution and status of breeding birds of Ladakh, the survey was conducted in summer (from mid-June to mid-July, 2000).

Inventories of breeding bird species in a locality were made through intensive and systematic search efforts; only relative abundance of population on an ordinal score was attempted as the survey was designed particularly to capture all possible breeding species within such short time, thus enhancing the quality of data output per unit effort

per unit time. Moreover, the survey period was too short to standardize any census technique as the terrain quality and landscape type precluded any ad hoc choice (the literature in this regard is also limited). With every sighting, the following parameters were recorded:

- a. Geographical position / latitude-longitude data, using a Garmin GPS version 3.01
- b. Altitude in m, using both GPS and altimeter:
While using GPS in both cases, the readings were recorded once the receiver started getting three-dimensional readings (at least, 4 satellite signals). Further, the records were noted only when the EPE (Estimated Position Error) was below $\pm 50\text{m}$, and
- c. Habitat type.
Besides, several other information were also collected wherever possible; these include the time of observation, dominant vegetation, nesting signs (old & current), songs & calls, and any other significant behavioural observations. PS recorded songs and calls of most of the birds using Sony© DAT Recorder and Parabolic Receiver. In total, 97 species of birds were recorded in the survey out of about 110 species that are known to breed in Ladakh regularly (c. 88 %).

7.6 Species Accounts

Snowcock (*Tetraogallus* sp.):

Whistling calls heard from ridge tops in Zaskar valley around Rangdum (4150 m) and the base of Penzi La glacier (4100 m). Since both *T.himalayensis* and *T.tibetanus* are said to have similar calls, species identity remains uncertain. However, Holmes (1986) recorded only *T.himalayensis* from these localities; Mallon (1987) and Pfister (1998) recorded *T. tibetanus* only from eastern Ladakh. Further confirmation required. Pfister (*in litt.*) opines that the two species probably meet along the axis of Taglang La – Chang La in western Rupshu.

Chukar (*Alectoris chukar*):

Quite common along open, rocky mountains of Indus valley, increasingly rarer above 4200 m. Absent from most of Suru and Zaskar valleys; very scarce west of Lamayuru (between Mulbek and Kargil ranging from 2800 to 3430 m). Uncommon in eastern Ladakh; six individuals seen on 11-7-2000 amidst *Myricaria* dominated rocky valley-bottom between Sumdo and Mahe bridge (4250 m). Interestingly, Pfister (1998) has several records of Tibetan Partridge (*Perdix hodgsoniae*) from here. Commonly predated by red foxes and domestic dogs.

Bar-headed Goose (*Anser indicus*):

Breeds commonly at high-altitude lakes of eastern Ladakh. At least five pairs were seen in the fresh-water part of Tso Kar lake (4600 m), while several breeding pairs with chicks seen in Tso Moriri lake (4580 m). Maximum number of chicks seen with a pair is five though most of them had 3 or 4 chicks on an average.

Ruddy Shelduck (*Tadorna ferruginea*):

Breeds commonly on ridges around high-altitude lakes and occasionally cliffs facing streams / rivers. Several breeding pairs (some with juveniles) seen at Tso Kar (4600 m) and Tso Moriri lakes (4580 m). Generally seems to have a higher clutch size than the sympatric Bar-headed Goose; one pair in Tso Moriri had 11 chicks! A pair was seen at Indus river near Loma bridge (4170 m) on 12-7-2000, while another with 3 chicks seen in backwater pool near Rongo village (4200 m) in Chang Thang.

Gadwall (*Anas strepera*):

Normally a winter visitor, some individuals are said to oversummer in Ladakh. On 30-6-2000 one male was seen in a grassy margin of Suru river between Parkachik and Rangdum (4000 m). On 6-7-2000, one pair with an immature (!) was seen in Trishul tank, Spituk (3500 m). Sporadic breeding in Ladakh not ruled out.

Incidentally, several individuals of *Anas*, *Aythya*, and *Rhodonessa* do occur in Ladakh in summer; but their breeding status in Ladakh is uncertain and deserves an exploratory survey (Pfister *in litt.*).

Eurasian Wigeon (*Anas penelope*):

One oversummering female seen at Trishul tank, Spituk (3500 m) on 6-7-2000.

Mallard (*Anas platyrhynchos*):

One pair was seen at Trishul tank, Spituk (3500 m) on 3-7-2000 and on another occasion a single female was seen in the fresh-water section of Tso Kar lake (4600 m) on 9-7-2000. Not known whether these individuals are from breeding or oversummering population, as Mallards are known to breed occasionally in Kashmir valley.

Garganey (*Anas querquedula*):

One female was seen in fresh-water part of Tso Kar lake (4600 m) on 9-7-2000. Possibly an oversummering individual.

Red-crested Pochard (*Rhodonessa rufina*):

Two females with one immature (sex unknown) seen at Trishul tank, Spituk (3500 m) on 6-7-2000 could be oversummering.

Common Pochard (*Aythya ferina*):

Two males were seen at Trishul tank, Spituk (3500 m) on 6-7-2000; oversummering individuals?

Ferruginous Pochard (*Aythya nyroca*):

One male in breeding plumage seen at the fresh-water part of Tso Kar lake (4600 m); possibly breeding at the nearby reedy backwaters. First record for Ladakh.

Tufted Duck (*Aythya fuligula*):

Three oversummering individuals (sexes unknown) seen at Trishul tank, Spituk (3500 m) on 6-7-2000.

Common Merganser (*Mergus merganser*):

Typically breeds in rivers of Ladakh though they were nowhere gregarious in this season. One male in breeding plumage seen on 6-7-2000 resting on shores of Trishul tank, Spituk (3500 m) and a pair with three chicks seen foraging along Indus river near Mahe bridge (4200 m) on 11-7-2000.

Eurasian Wryneck (*Jynx torquilla*):

An unobtrusive, yet common breeder in and around countryside *Salix* plantations. One individual was seen flying with food in bill on 20-6-2000 in a dense *Salix* plantation near Gompa village, Leh (3650 m). More commonly met with in lower Suru valley in the vicinity of riverine plantations and *Hippophae* clumps (2800 – 3400 m).

Common Hoopoe (*Upupa epops*):

Commonly breeds around villages in Indus valley and Suru & Zaskar valleys; uncommon in Chang Thang region above 4100 m. Most of the breeding birds were seen carrying food materials in their bills, indicating the presence of fledglings in nests. The nests were invariably placed amidst cavities of rooftop hay-stack in houses.

Eurasian Cuckoo (*Cuculus canorus*):

One individual constantly heard at Shey village (3400 m) from dense poplar grove at 0730 hrs on 7-7-2000.

Common Swift (*Apus apus*):

One pair (breeding?) along Suru river flanked by steep rocky cliff near Parkachik village (3700 m) seen on 25-6-2000. On another occasion (1-7-2000), a small party of six individuals seen flying over Suru river near Sankoo (3150). Seems to be a common breeder along lower Suru valley. Not recorded from Upper Indus or Chang Thang areas, though may breed in Nubra valley.

Fork-tailed Swift (*Apus pacificus*):

A little known bird from Ladakh. We saw two individuals (breeding pair?) at Panikhar Checkpost (3400 m), flying over ridges on 25-6-2000. Occasionally met with in Zaskar valley where three of them once seen flying across Tsarap river near Padum (3610 m) on 28-6-2000. Possibly more common than the records indicate. Not encountered in Upper Indus or Chang Thang areas.

Little Owl (*Athene noctua*):

On 11-7-2000, one bird was seen perching on a small rock near the northern mouth of Tso Moriri lake (4580 m) at 1000 hrs. The locality was characterized by gentle, sandy slope strewn with small rocks and Caragana bushes. Interestingly, this was the only record of owls in our survey.

Rock Pigeon (*Columba livia*):

One of the abundant birds of Ladakh; both the feral and wild populations occur upto an altitude of 4200 m after which Hill Pigeons replace them. However, both *C. livia* and *C. rupestris* were found together at several localities between 3500 m and 4200 m. [See next species for detailed information on sympatry of these two pigeons]. May raise more than one brood in a season.

Hill Pigeon (*Columba rupestris*):

In the Indus valley, replaces Rock Pigeons after 4200 m altitude, though they are found in small numbers from 3500 m along with the more abundant *C. livia*. However, Hill Pigeons were more common in Suru and Zaskar valleys and in fact, Rock Pigeons were absent from most of these valleys. The localities where *C. livia* and *C. rupestris* were observed to be sympatric in this survey are provided below:

Date	Site	Locality	Altitude
25-6-2000	Near Panikhar	Suru valley	3500 m
25-6-2000	Tangole	Suru valley	3500 m
29-6-2000	Padum	Zaskar valley	3610 m
29-6-2000	Phey	Zaskar valley	3670 m
02-7-2000	Lamayuru	Indus valley	3580 m
03-7-2000	Wanla	Wanla valley	3260 m
06-7-2000	Spituk	Indus valley	3500 m
07-7-2000	Near Meru	Rupshu	3650 m
12-7-2000	Rongo	Chang Thang	4200 m

Hill pigeons were seen in Suru valley from Damsna village upwards (3300 m). In Rupshu, they are common above 4100 m; on 7-7-2000, a huge flock of c. 200 Hill Pigeons were seen on the eastern side of Tso Kar lake (4600 m) and they were also common around Tso Moriri (4580 m).

Snow Pigeon (*Columba leuconota*):

Seen fluttering around snow-capped ridge tops of mountains in Suru valley, emitting a somewhat metallic "goon...goon..." calls on the wing. Not seen in Indus valley and Chang Thang region though presumably occurs in the latter. Higher annual precipitation rate of Suru and Zaskar valleys possibly supports this population. On 26-6-2000, a flock of 18+ seen at Rangdum (4150 m), while another group was seen at Tangole (3440 m) in Suru valley.

Oriental Turtle Dove (*Streptopelia orientalis*):

One of the opportunistic species that has exploited the human-made changes in the region's barren landscape. Quite common around cultivation and plantations, foraging largely on freshly-sown crop-fields. In particular, very common along Lower Indus and Suru valleys (between 2800 and 3650 m); rare in Zaskar valley probably due to scarcity of old-growth tree plantations. Also not encountered in Chang Thang region.

Black-necked Crane (*Grus nigricollis*):

A flagship species of biodiversity conservation in Ladakh. Breeding recorded only from eastern Ladakh (Chang Thang, Rupshu, Chushul, and Hanle areas). One individual was seen on 9-7-2000 near a sulphur extraction plant between Tso Kar and Sumdo (4500 m) in the Puga plains. On 12-7-2000, one pair with a juvenile was seen on a grass-dominated wetland (4250 m) adjacent to River Lalpari between Hanle and Ronga; there were about six livestock camps of nomads nearby with grazing flocks of sheep, goats and horses. The Forest Dept. staff informed us that there are six known breeding pairs between Nyoma and Hanle (4200 m). Local people in Suru valley claim that the cranes occasionally visit wet, turf-grass pasturelands of riverbeds characteristically found around Rangdum (4150 m) in Aug-Sep.

Common Coot (*Fulica atra*):

Breeding status uncertain in Ladakh; Shey wetlands (3550 m) harbour a small population, possibly breeding (8 were seen on 17-6-2000). Another population was at Trishul tank, Spituk (3500 m) where 7 were seen on 3-7-2000. In Kashmir valley, known to breed up to an altitude of 2500 m.

Common Redshank (*Tringa totanus*):

A locally common breeder at the high-altitude wetlands above 4200 m. Commonly seen breeding in wetlands along Suru river between 3800 and 4200 m (e.g., Sheep Husbandry Dept.'s Grazing Camp @ 4000 m between Parkachik and Rangdum, and turf-grasslands near Rangdum @ 4150 m). A big population of c. 150 birds seen foraging in the freshwater part (Startsapuk-Tso) of Tso Kar lake (4600 m) on 7-7-2000, though only a couple of breeding pairs seen nearby. On 12-7-2000, a solitary bird was seen foraging in a small pool of water on riverbed near Rongo village (4200 m).

Green Sandpiper (*Tringa ochropus*):

Fairly common along rivers and streams above 4000 m. Though most of them are overwintering population, we suspect a few may actually breed in isolated pockets. Solitary individuals were seen in Suru valley – one near Rangdum (4150 m) on 25-6-2000, one at the lake near Penzi La Top (4290 m) on 27-6-2000, and another bird on the shore of a lake at the base of Penzi La glacier (4100 m) on 29-6-2000. One pair was seen in a swamp country at Tso Kar (4600 m) on 8-7-2000, and another pair in a small pool between Rongo and Hanle (4300 m) seen on 12-7-2000. Several solitary birds were seen between Mahe bridge (4200 m) and Loma bridge (4200 m) along Indus river.

Common Sandpiper (*Actitis hypoleucos*):

One pair in breeding plumage seen on the banks of a stream near Rongo village (4200 m) on 12-7-2000 was the only record of the species in our survey. Apparently a sporadic breeder in Ladakh and further investigations required.

Lesser Sand Plover (*Charadrius mongolus*):

Breeds commonly along edges of high-altitude wetlands often sharing the same locality as Common Redshank – while the former frequents drier plateau, the latter haunts moist turf country next to wetlands. Several solitary birds were seen along Suru riverbed from Sheep Husbandry Dept.'s Grazing Camp (4000 m) till the base of Penzi La glacier (4100 m) in the last week of June, 2000. Some pairs were breeding on the dry, stony plateau of Tso Kar lake (4600 m) in first week of July, 2000; in one instance, a female, on being approached, performed a prolonged broken-wing display, while the male scooted away into Caragana bushes in Tso Kar on 8-7-2000.

Red-wattled Lapwing (*Vanellus indicus*):

One bird was heard from Rongo village (but not seen) in Chang Thang (4200 m) on 12-7-2000. A possible case of Bluethroat (*Luscinia svecica*) mimicking the lapwing's calls (see the account given under Bluethroat in this report). Pfister (in litt.) also had similar experiences from Tso Kar in July 1996 and 1997.

Brown-headed Gull (*Larus brunnicephalus*):

Seen regularly foraging over rivers, lakes, and sometimes even small streams, mostly at higher altitudes above 3800 m. On 7-7-2000, one pair (breeding?) was seen over Startsapuk-Tso (4600 m). Though it is a breeding hotspot for Brown-headed Gull (Pfister, in litt.), we did not encounter the breeding population as our itinerary did not cover the south-east part of the lake. Solitary foraging individuals were commonly seen along streams from Tso Kar to Tso Moriri (4580 m) via Sumdo. One individual seen along Indus river near Kidmang (3850 m) between Upshi and Mahe bridge. Not recorded by us from Zaskar and Suru valleys.

Common Tern (*Sterna hirundo*):

One of the two common terns breeding in Ladakh; while the Common Tern breeds along rivers, the Whiskered Tern is largely confined to lakes. More common in Zaskar and Upper Suru valleys; one bird was seen along Suru river near Parkachik (3700 m) on 25-6-2000, and a pair (breeding?) near Rangdum (4050 m). Three breeding pairs observed on 28-6-2000 at pebble-islets of Zaskar river below Thondhe village (3600 m) near Padum; though the nests were not located, panic behaviour of birds emitting harsh alarm calls indicate to their possible nesting. Recorded twice from Lower Indus – one along Wakha river at Hiniskut village (3720 m) on 2-7-2000, and another from Trishul tank, Spituk (3500 m) on 3-7-2000. One record from Upper Indus between Mahe bridge and Nyoma (4200 m) on 11-7-2000.

Whiskered Tern (*Chlidonias hybridus*):

Commonly seen foraging over lakes, jheels, and tanks, and occasionally along rivers. One bird was regularly seen at Trishul tank, Spituk (3500 m), and another at freshwater part of Tso Kar lake (4600 m) in the first week of July, 2000. On 10-7-2000, one pair (breeding?) was seen mobbing a juvenile Golden Eagle on the western bank of Tso Moriri lake near Korzok (4580 m). Not recorded by us from Suru and Zaskar valleys.

Lammergeier (*Gypaetus barbatus*):

Seen regularly soaring over ridge tops and countryside. On 22-6-2000, one bird was seen circling over mountains facing Sankar village, Leh (3650 m); heavy snowfall at higher reaches in the morning probably drove the bird down. Another adult was seen low over the freshwater stream near Korzok village, Tso Moriri (4580 m).

Eurasian Sparrowhawk (*Accipiter nisus*):

An opportunistic species that breeds in wooded compounds of villages. Though its breeding season in the main Himalayas is said to be between April and June (e.g., Grimmett et al., 1999), nesting in Ladakh is mostly between late July and early October (as observed in our autumn survey, 1999). One pair seen inspecting an old nest (apparently belonging to a pair of Common Kestrels which bred there in 1995 & 1996, according to Pfister *in litt.*) placed c. 12 m high on a tall poplar tree near the Taxi Stand, Leh (3500 m) on 6-6-2000; a pair of Red-billed Choughs were mobbing them. On 21-6-2000, one female was seen perching on a low branch in a poplar grove near Gompa village, Leh (3650 m).

Golden Eagle (*Aquila chrysaetos*):

A characteristic raptor of Ladakh mountains, seen usually soaring over alpine pastures and grazing camps. One bird was seen being mobbed by a nesting pair of Blue Rock Thrushes at Sankar Ridge, Leh (3650 m) on 22-6-2000. Another adult was regularly seen in Tso Kar plateau near the lake (4600 m) during the first week of July. A juvenile was seen being mobbed by a pair of Whiskered Terns at Tso Moriri lake shore near Korzok village (4580 m) on 10-7-2000; another juvenile was seen sitting on the riverbed just below the Hanle Gompa (4290 m) 12-7-2000. Though we did not come across it in Zaskar, our socio-economic survey reveals that Golden Eagles here take a heavy toll on lambs of sheep and goats.

Common Kestrel (*Falco tinnunculus*):

Commonly seen all through Ladakh around cliffs and adjacent valleys, especially between 3200 and 3800 m; almost every ridge will have one breeding pair which is highly territorial. On 21-6-2000, one male was seen feeding on a small bird (possibly a House Sparrow) in a crop-field near Gompa village, Leh (3650 m).

Eurasian Hobby (*Falco subbuteo*):

An uncommon falcon that breeds sporadically in Ladakh. One pair (breeding?) regularly seen hawking over the Shey wetlands (3550 m) where Citrine Wagtails breed abundantly; one of the falcons was seen once taking off a rodent from the swamp on 17-6-2000. Our another record of the species was from Leh, where one bird was frequently seen around the Shanti Stupa hills (3600 m).

Great Crested Grebe (*Podiceps cristatus*):

A common breeder at high-altitude lakes in eastern Ladakh (Chang Thang). In a census at Tso Kar lake (4600 m) on 9-7-2000, we counted 23 birds (4 pairs + 15 chicks); one pair with 5 chicks, another with 4 chicks, and two pairs with 3 chicks each were recorded. On 10-7-2000, 4 pairs in total were seen with chicks at Tso Moriri lake.

Indian Pond Heron (*Ardeola grayii*):

PS saw one bird in breeding plumage on the Yapola river bank, near Wanla village (3260 m) on 3-7-2000. A few isolated records in the past; Pfister (1998) has recorded from Nubra valley as 'occasional' during September, 1997.

Long-tailed Shrike (*Lanius schach*):

Commonly seen amidst the Hippophae patches of Wakka Chu nallah near Mulbek (3430 m) and also the adjacent Lower Suru valley around Kargil (2850 m). Another disjunct population was found in Zaskar region – one individual from cultivated landscape of Padum (3610 m) seen on 28-6-2000, and another from the nearby village of Sani (3580 m) on 29-6-2000. Holmes (1986) infers that both *L.schach* and *L.tephronotus* are sympatric in Zaskar and the former may be replacing the latter, seen from the fact that there are no recent records of *L.tephronotus* from Zaskar; we also did not come across it in our survey from there.

Grey-backed Shrike (*Lanius tephronotus*):

Found in small numbers in Hippophae-dominated scrub patches; one seen at Sankar village, Leh (3500 m) on 16-6-2000, and another near Sind Darshan ghat (3550 m) between Shey and Choglamsar on 7-7-2000. The population in Zaskar is apparently under threat from the invasion of *L.schach*. Incidentally, Hippophae scrubland – the typical habitat of Grey-backed Shrike is facing the threat of elimination by the expanding cultivation practices and Salix plantations in the Indus valley further pushing the species to the edge.

Black-Billed Magpie (*Pica pica*):

One of the common birds of Ladakh, though the abundance seems to vary across different landscape units. Very common along Lower Indus valley, up to Kaisher (4020 m), after which it becomes increasingly rarer. Rare or absent from most areas in Rupshu and Chang Thang (e.g., Tso Kar, Tso Moriri, and Hanle). Uncommon around Suru and Zaskar valleys. Several old nests were observed in poplar trees in wooded compounds of Leh (3500 m). Some juveniles (immatures?) were with bare necks, devoid of feathers.

Red-billed Chough (*Pyrrhocorax pyrrhocorax*):

A common scavenger of Ladakh, often occurring together with its congener Yellow-billed Chough [e.g., Zaskar valley (3550 – 4150 m), Wanla (3260 m) & Lamayuru (3580 m), Upper Indus valley, valley from Meru to Gya (3780 – 4100 m), and Rupshu plateaus (4600m)]. Where they are sympatric, Red-billed Choughs are less of a scavenger, foraging outside human habitations by digging into the ground and Yellow-billed Choughs take over the scavenging niche. The variations in their bill shape thus seem to have evolved in response to their differential foraging behaviour (or vice versa?). One juvenile was seen being fed by a parent atop a house near Taxi stand, Leh (3500 m) on 22-6-2000. A family of three juveniles and parents was seen on a old poplar tree in the premises of Sani Gompa (3580 m), Zaskar on 29-6-2000. On another occasion, a nest with two fledglings was seen at Gya (4100 m); the nest was placed in a cavity amidst the hay-stack on the roof top of a house. Common in plateaus around Tso Kar & Tso Moriri (4600 m) where huge flocks (> 100) were seen in the first week of July.

Yellow-billed Chough (*Pyrrhocorax graculus*):

A locally common scavenger with an irregular distribution pattern across Ladakh (see Red-billed Chough for details of sympatry with the latter). Regularly seen along Upper Suru valley and Zaskar valley, occurring from c. 3000 to 4500 m. Uncommon in Indus valley barring some isolated pockets where found in good numbers - e.g., Lamayuru (3580) and Gya - Meru - Rumtse stretch (3780 - 4200 m). Rare in Chang Thang and Rupshu (4300 - 4600 m), where Red-billed are abundant. Such a queer distribution of both the species of choughs, defying the generally-held notion of altitudinal segregation is intriguing and warrants further investigations.

House Crow (*Corvus splendens*):

One bird was seen at Rangdum village, Zaskar (4150 m) on 26-6-2000, hanging around our camping-site. The possibility of its identity being *Corvus corone* *sharpii* ("Hooded Crow") was examined on the spot and rejected after carefully corroborating the field-characters including calls. Very few records in the past.

Carrion Crow (*Corvus corone*):

Not uncommon around countryside particularly in the Indus valley; sporadic in other regions of Ladakh. PS saw a pair near Leh on 17-6-2000, and one bird was seen at Chubi, Leh (3550 m) being mobbed by a pair of Black-billed Magpies on 22-6-2000. A flock of six birds was sighted near Fotu La (4100 m) on 24-6-2000. The vast stretches of stony uplands that lie between the rising hills and the riverbed are particularly favoured.

Large-billed Crow (*Corvus macrorhynchos*):

Rare. One individual was seen at Upshi (3500 m), just before the bridge across the Indus, on 7-7-2000. Caution is required in field in distinguishing this species from *C. corone*.

Common Raven (*Corvus corax*):

A familiar bird of nomadic livestock camps, army establishments, and grazing pastures in high-altitude plateaus of Ladakh; quite common and gregarious in Chang Thang and Rupshu areas in eastern Ladakh above 4100 m. They were also found in small numbers around mountain-passes of central Ladakh - a small flock (<20) about an army camp between Lamayuru and Fotu La (3500 m) seen on 24-6-2000, and a pair was seen foraging on a barren hill-slope near Namika La (3550 m) on 2-7-2000. At Tso Kar (4600 m), one bird was observed feeding on the bone-marrow of horns in a sheep carcass on 8-7-2000. A ubiquitous scavenger in villages around Tso Kar and Tso Moriri plateaus. Possibly occurs in Penzi La and Rangdum in Zaskar, though we did not encounter in our survey.

White-throated Dipper (*Cinclus cinclus*):

A common bird that frequents small rivers and streams of inner valleys (where turbulence of water is very minimal) throughout Ladakh, seen from 3150 m (e.g., Sankoo in Suru valley) to 4600 m (e.g., Rupshu area). Several sightings of juveniles indicate that the peak nesting season was over by June. One male (?) was, however, singing near Korzok, Tso Moriri plateau (4580 m) on 10-7-2000.

Brown Dipper (*Cinclus pallasi*):

Apparently rare in Ladakh, being found only at lower reaches of large rivers below 3200 m altitude. Pfister () studied the winter distribution of both the dippers and found that the altitudinal limit of 3600 m was the dividing line between them. Our only record of the species was along Yapola river (3050 m) between Khaltse and Lamayuru on 24-6-2000.

Blue Rock Thrush (*Monticola solitarius*):

Regularly seen along rocky, barren mountains, often foraging at the foot of the ridges in Indus, Suru, and Zaskar valleys; found between 3500 m (e.g., Leh) and 4050 m (e.g., Lato near Gya). Not seen in Chang Thang or Rupshu. During our survey, almost all the males seen were singing and there were lots of nesting activity.

Blue Whistling Thrush (*Myophonus caeruleus*):

Found in small numbers along the Indus valley, this bird was surprisingly little recorded from Ladakh by early workers; though, Mallon (1987) notes that it is found sporadically throughout the region (?) in summer. Along the Lower Indus, we had four records of the thrush on 24-6-2000: one at Bazgo (3050 m), a pair near Nurla (3200 m), one between Fotu La and Namika La (3650 m), and the last was a solitary bird from Kargil (2850 m). Not seen in Upper Suru or Zaskar valleys nor from Chang Thang.

White-tailed Rubythroat (*Luscinia pectoralis*):

Though it is not uncommon in suitable sites, rarely seen due to its skulking behaviour; prefers *Caragana* bush country either on the lower slopes of hills or more along stream banks. Two morphologically distinct races occur in Ladakh; the western race *L. p. pectoralis* is found in Suru / Zaskar valleys, and the eastern race *L. p. tschebaiewi* in Chang Thang. Though the eastern population is stated to be stable, the population of

western race is seemingly on the decline (Pfister *in litt.*) We had only a couple of sightings of *L. p. tschebaiewi* at Penzi La base (4100 m) amidst *Rosa* shrubs of rocky slopes on 30-6-2000. As to *L. p. pectoralis*, one pair was seen in riverine *Caragana* bushes at Sumdo (4450 m) on 11-7-2000 and another pair sighted in a similar habitat near Rongo (4200 m) between Loma Bridge and Hanle on 12-7-2000. The subspecies identification of a pair observed near Bazgo (3050 m) is uncertain.

Bluethroat (*Luscinia svecica*):

A familiar species that faithfully haunts Hippophae scrub-growth along streams and rivers up to c. 3650 m; seen in the survey in Lower Indus and Lower Suru valleys. Most of the pairs were observed to be either attending to the nest or feeding the chicks. The songs of several males were interspersed with snatches mimicking other birds; one male was heard mimicking Red-wattled Lapwing near Shey (3300 m) on 17-6-2000, and another giving out Common Tailorbird's "towhee" calls at Gompa, near Leh (3600 m) on 20-6-2000. There are two breeding forms of males, found in Ladakh: one with white 'star' on breast (the predominant form), and another with red 'star' suffused with white; no spatial segregation noted and they were often seen together in same area. Interestingly, Pfister (*in litt.*) observes that the 'red star' population is the dominant one in the eastern Ladakh.

Blue-capped Redstart (*Phoenicurus coeruleocephalus*):

One bird was seen at Padum, Zaskar valley (3610 m) in a young *Salix* plantation opposite to J & K Tourist Bungalow, on 27-6-2000. Being an essentially arboreal species, this redstart may be expected to invade other parts of Ladakh as more plantations come up along the river valleys. First record for Ladakh.

Black Redstart (*Phoenicurus ochruros*):

Arguably the most common bird in Ladakh; frequents a wide range of habitats from cultivation and plantations to scrub-covered barren ridges, and common up to an altitude of c. 4100 m above which it becomes increasingly rarer (e.g., Rangdum in Upper Suru valley, Tso Kar & Tso Moriri plateaus, and Chang Thang). Seems to have a prolonged, staggered nesting season, with several pairs observed were in various breeding stages; first-year males resemble females and many of them were singing, particularly around Leh (3500 m) and Sumdo (4450 m) in late June and early July.

White-winged Redstart (*Phoenicurus erythrogaster*):

Quite commonly seen between 4100 and 4600 m, though occasionally found at lower altitudes down to 3600 m (e.g. Upshi) in the breeding season. Has a strong preference in this season for steep, rocky precipices invariably those flanking rivers; also found in boulder-strewn turf country. In many localities, sympatric with the less common White-capped Water Redstart. Most of our sightings were from Lato - Gya stretch (4050 - 4200 m) between Upshi and Rumtse, and our records from Zaskar were confined to Penzi La (4100 - 4550 m), and Nun - Kun base (3750 m). On 10-7-2000, a male was seen singing near Korzok, Tso Moriri (4580 m). Though a male juvenile was once sighted between Sumdo and Mahe bridge (4300 m) on 11-7-2000, the birds were, in general, seen either singing or guarding the territory.

White-capped Water Redstart (*Chaimarrornis leucocephalus*):

An uncommon bird seen along rocky streams and rivers, often in association with White-winged Redstart. One pair was seen near Parkachik village along Suru river (3700 m) on 25-6-2000. Several individuals sighted from Lato -- Gya -- Rumtse stretch (4050 - 4350 m) between Upshi and Taglang La in the first week of July.

Variable Wheatear (*Oenanthe picata*):

Very few breeding records in the past, all from Lower Suru valley near Kargil (see Holmes, 1986). However, we recorded its breeding in Lower Indus valley in this survey; one pair was seen nesting in a rocky ridge facing open stony country between Khaltse and Nurla (3170 m), and another pair c. five km up on 3-7-2000. Probably breeds in good numbers than the past records indicate. We strongly recommend to future workers a thorough verification of species identity in the field as some of the *Oenanthe* chats are notoriously similar-looking; for e.g., i) *Oenanthe picata picata*, the resident race (morph?) in Ladakh and Hume's Wheatear (*O. alboniger*), ii) *Oenanthe picata capistrata* and Pied Wheatear (*O. pleschanka*), and iii) Desert Wheatear (*Oenanthe deserti*) and Isabelline Wheatear (*O. isabellina*).

Pied Wheatear (*Oenanthe pleschanka*):

Recorded only from Lower Suru valley and Wakka Nalla valley, between 2800 and 3200 m. Frequents same habitat as that of Variable Wheatear. Two pairs (one with two juveniles) were seen in a rocky ground along Suru river near Trespone village (2950 m) between Kargil and Sankoo on 25-6-2000, and another pair at Damsna village (3200 m) along the same valley. Commonly seen about open rocky country along Wakka Nalla between Hiniskut and Mulbek (2900 – 3400 m).

Desert Wheatear (*Oenanthe deserti*):

A familiar bird of Ladakh found from 3200 m high up to 4750 m; one of the early breeders that begins nesting in May and by the end of June we saw several juveniles being fed by parents. [However, males in Zaskar were still seen singing and guarding territories]. The juveniles seemed to have two different calls: a hard "tack...tack" note, apparently to help parent locate them, and the usual begging note emitted once the parent arrives with food. Strongly favours crevices below isolated rocks on the ground, for nesting. Though Desert Wheatear is common in most parts of Ladakh, we did not find it along Lower Suru valley (2800 – 3400 m) and Wakka Nallah stretch (2900 – 3430 m).

Brahminy Starling (*Sturnus pagodarum*):

The only population recorded earlier in Ladakh is from Hanle, Chang Thang (Pfister, 1998). Hence, our record from Zaskar apart from Chang Thang is significant; PS saw an individual at Pipiting, Padum (3610 m) on 28-6-2000, and another bird at Nyoma, Chang Thang (4210 m) on 11-7-2000. Probably expanding its distribution from east to west through the spread of *Salix* plantations. (There is a small breeding population in the adjacent Spiti valley in Himachal Pradesh).

Winter Wren (*Troglodytes troglodytes*):

Though it is sparsely distributed over most of the Ladakh, it was recorded in the survey only from Indus valley (3500 – 3750 m) invariably around wooded compounds along rivers and streams. [Its apparent preference for rocky plantations with dense cover in these areas is in sharp contrast to the published literature, which state that Winter Wren breeds amidst barren rocks in moraines and screes]. Most of the males were in full song in the second half of June and a couple of juveniles were heard from a riverine poplar stand at Sankar, Leh (3600 m) on 19-6-2000.

Great Tit (*Parus major*):

An opportunistic species that tracks old-growth poplar and willow plantations, and often found together with Oriental Turtle Dove (*Streptopelia orientalis*). Hence, common in Lower Indus valley and Suru valley from 2800 m to 3650 m, and rare or absent from Zanskar, Rupshu, and Chang Thang areas. Most of the birds started singing around the middle of July though a few pairs were seen with juveniles (e.g., one family of two fledglings at Gompa village, near Leh on 21-6-2000). Song may sometimes be confused with that of Mountain Chiffchaff (*Phylloscopus sindianus*).

Pale Martin (*Riparia diluta*):

One of the significant findings of the survey is that of the occurrence of Pale Martins in Ladakh in summer; we observed a flock of 8 individuals hawking along Indus river near Mahe bridge (4200 m) on 14-7-2000. Incidentally, Pfister (*in litt.*) has recorded nesting of the species in the same locality. Grimmett et al (1998) give the range as Pakistan and also state that they possibly breed further east. A little-known species to look out for in future surveys, as its distribution, ecology, and population status are poorly understood.

Eurasian Crag Martin (*Hirundo rupestris*):

Commonly seen foraging over rivers and large streams flanked by rocky cliffs and precipices from 3200 m (e.g., between Mulbek and Namika La) to 4300 m (e.g., Hanle). In particular, the stretches of mountain streams between (a) Loma bridge and Rongo [4100 - 4250 m], (b) Parkachik and Zuido - Rangdum [3430 - 4150], and (c) Upshi and Meru - Gya [3400 - 4100] harbour a good population.

Barn Swallow (*Hirundo rustica*):

Occasionally seen around cultivation in Zanskar and Chang Thang areas, and possibly more common than the past records indicate. However, we did not come across in Lower Indus and Suru valleys. One nest with three fledglings was found inside the J & K Tourists Bungalow at Padum (3610 m) on 28-6-2000; it was placed on to the wall close to the ceiling, and the parent birds were attending to the chicks alternately [while the same day we also saw their mating at 0740 hrs on a powerline]. This could be the first confirmed breeding record of Barn Swallows in Ladakh, though Ali & Ripley (1983) hinted at possible nesting. Our other records include one bird seen near Korzok, Tso Moriri (4580 m) on 10-7-2000 and another individual near Mahe bridge (4200 m) on 11-7-2000.

Wire-tailed Swallow (*Hirundo smithii*):

There seems to be only one record in the past, and hence the sighting of one male (by PS) in Pipiting, near Padum (3600 m) in a cultivated landscape on 28-6-2000 assumes significance.

Northern House Martin (*Delichon urbica*):

A familiar bird of high-rising cliffs often seen soaring high over the adjacent rivers and valley-bottom. More common in Zaskar and Upper Suru valleys, where such lofty cliffs flank the rivers, and there was a small population between Khaltse and Lamayuru (3100 m) along the Yapola river gorge. Scattered flocks were also regularly seen along the Indus river between Upshi and Mahe bridge (3400 – 4150 m). On 25-6-2000, one pair was observed constructing a saucer-shaped nest on to a rock fissure in a high ridge, at about 80 m from the ground, between Parkachik and Zilda in Suru valley (3700 m).

Mountain Chiffchaff (*Phylloscopus sindianus*):

A characteristic species of Ladakh, commonly seen up to 4200 m and absent only from high-altitude plateaus and passes (e.g., Tso Moriri, Tso Kar, and Penzi La). Originally an inhabitant of stony scrub country, Mountain Chiffchaff has now successfully adapted to the poplar and dwarf willow plantations that have sprung up all over the region. We estimated the density of breeding populations (through call-counts) as 1 pair / 900 m² around Leh in the last week of June. By this time, most of the birds were seen carrying food in the bill, pointing to the presence of nestlings; *Hippophae* shrubs, in particular, were favoured for nesting. While its distribution was uniformly abundant from Upshi downwards (< 3500 m) along the Indus, the population got increasingly rarer beyond Upshi; Nyoma (4210 m) on the south-east and Rumtse (4250 m) on the south almost marked the end of their distribution.

The taxonomical status of Ladakh population needs to be investigated through systematic collections and records of calls and songs. Apparently, *Phylloscopus sindianus* emits a distinctly double-noted call while the closely related *P. collybita* emits a plaintive, single-noted 'peu' (see Grimmett et al, 1998). But, in our survey, we heard only the single-noted call, besides the song (which is not very different from that of *P. collybita*) and the double-noted calls, supposed to be characteristic of *P. sindianus* were never heard by us in the survey. Interestingly, the double-noted calls were commonly heard during our survey (RJ) in September - October, 1999. We infer from these observations that while *P. sindianus* does emit 'peu' note as alarm call in its nesting period (in contrast to what the literature says), the double-noted calls are given forth outside the breeding season. However, this needs to be corroborated by other independent observations from Ladakh. Meanwhile, we do not rule out the possibility of sporadic breeding of *P. collybita* in Ladakh, as a few individuals seen near Shey wetlands on 17-6-2000 had distinctly bright lemon-yellow wing bend.

Tickell's Leaf Warbler (*Phylloscopus affinis*):

Not uncommon among *Caragana* and other shrubs on riverbeds, especially between 4100 m (e.g., base of the Penzi La glacier) and 4600 m (e.g., Tso Kar plateau). The *Phylloscopus* warblers that commonly breed amidst the *Caragana* bushes around Sumdo village (4450 m) are probably *P. affinis* (RJ), though PS is of the opinion that they are *P. griseolus*; the songs recorded are under scrutiny for further confirmation.

Sulphur-bellied Warbler (*Phylloscopus griseolus*):

Commoner than *P. affinis* and invariably found about scrub-covered rocky slopes and sometimes shrubberies on riverbeds, from 3200 m (e.g., Yapola valley between Khaltse and Lamayuru) to 4300 m (e.g., Hanle). Very common in suitable habitats between Parkachik and Rangdum (3700 - 4150 m), and between Loma bridge and Hanle (4150 - 4280 m); in Chang Thang, a lot of nesting activities seen amidst riverine, *Caragana* bushes on 12-7-2000.

Hume's Warbler (*Phylloscopus humei*):

An unconfirmed sighting record from a old *Salix* plantation at Chamba (3050 m), near Sankoo on 1-7-2000 (RJ). Otherwise, a widespread passage migrant seen in good numbers during September - October and March - April.

Lesser Whitethroat (*Sylvia curruca*):

A familiar bird of Hippophae - *Salix* mixed vegetation, often found in association with Bluethroats. Found up to 3600 m, it is common along Lower Indus valley, Wakka Nallah (between Mulbek and Kargil), and Lower Suru valley; uncommon in Zaskar (Padum, 3600 m). One nest with fledglings was found deep inside a Hippophae shrub near Leh on 20-6-2000.

Hume's Short-toed Lark (*Calandrella acutirostris*):

Frequents stony plateaus and uplands, and characterized by a curious distribution pattern in Ladakh -

Locality	Sites	Altitudinal Range	Status
Rupshu	Rumtse - Tso Kar	4150 - 4600 m	Abundant
Chang Thang	Tso Moriri - Sumdo -Mahe bridge & Nyoma - Hanle	4100 - 4600 m	Common to Abundant
Zaskar	Rangdum - Sani - Padum	3500 - 3600 m	Common to Abundant
Lower Indus valley	Saspol - Bazgo- Taru	3400 - 3550 m	Isolated populations
Upper Indus valley	Chumathang - Mahe bridge	4100 - 4200 m	Occasional

Almost all the males were in song flight though some juveniles (thought to be of this species) were also seen in the first week of July; in Tso Kar, many birds were collecting nesting materials on 7-7-2000. Some individuals seen in Tso Kar had distinct pinkish base to the bill, instead of yellow lower mandible (Greater Short-toed Lark *C. brachydactyla*?).

Oriental Skylark (*Alauda gulgula*):

A common bird of crop-fields, grasslands, and grazing pastures, found up to c. 4200 m. Very common in Suru and Zaskar valleys, and a few selected sectors along Lower Indus valley (e.g., Shey to Leh & Bazgo to Saspol). Rare to absent from Upper Indus valley, Chang Thang, and Rupshu. Almost all males were performing song-flights, and at places 3 - 4 males acting together in a show of combat!

Horned Lark (*Eremophila alpestris*):

Another characteristic species of high-altitude stony plateaus, often found sympatric with Hume's Short-toed Lark - except along Indus valley where Horned Larks are seen only beyond Mahe bridge upstream. In general, occupies higher altitudinal range than the Short-toed Larks, i.e., from 3800 m (Upper Suru valley) to 5250 m (Taglang La). As other larks, most of the males were seen performing song-flights in the survey period.

House Sparrow (*Passer domesticus*):

A ubiquitous species that occurs about human habitations up to c. 4200 m above which becomes increasingly rarer, more so owing to the scarce human settlements above 4200 m; absent from high-altitude plateaus of Tso Kar and Tso Moriri (4600 m). Many pairs were seen collecting nesting materials by the end of June. Seem to favour young *Salix* plantations for their communal roosting. Some extended calls by males (songs?) are peculiar to the Ladakh population.

Tibetan Snowfinch (*Montifringilla adamsi*):

Commonly inhabits barren ridges and mountain slopes; often seen foraging in the adjacent crop-fields either fallow or freshly-sown. Distributed throughout Ladakh from c. 3480 m (near Lamayuru) to 5250 m (Taglang La); absent only from Lower Suru valley and Wakka Nallah stretch between Mulbek and Kargil. Most of the nests observed had fledglings by the end of June; the nests were invariably placed either in crevices under rocks or in hollows of stone-walls laid to support footpaths scaling up the hills. Some of the fledglings were seen being attended by more than two adult birds (extra-parental care?).

White-rumped Snowfinch (*Pyrgilauda taczanowskii*):

A little-known species of Tibetan steppe country. One individual was seen foraging on a stony ground at Fotu La (4100 m) on 24-6-2000. Described as an occasional summer visitor to Ladakh (Grimmett et al, 1998), there seem to be no nesting records other than the one which was observed by us (RJ & Dr. C.P. Kala) in Rumbak valley (4050 m) in late September, 1998. Specific surveys are required to assess its population and breeding status.

Plain-backed Snowfinch (*Pyrgilauda blanfordi*):

Though it is described as locally common in Ladakh by Grimmett et al (1998), we surprisingly had only one record in our survey, from Zaskar; PS saw an individual singing from atop a rock on the stony riverbed at the base of Penzi La glacier (4100 m) on 29-6-2000. Though Pfister (1998) recorded it as common in Tso Kar plains from June to August, we did not come across it in our survey.

White Wagtail (*Motacilla alba*):

Commonly breeds along mountain streams and rivers, up to 4600 m (Tso Kar). Most of the birds were seen carrying food in bill, indicating the presence of nestlings, though a few immatures were seen in Zanskar by the end of June; several of the nests observed were placed amidst crevices in stone-dykes. Though there is an altitudinal overlap with Citrine Wagtails, the optimal range of *M. alba* seems to be 3100 - 3600 m.

Two races of White Wagtails breed in north-west subcontinent – while *M. a. personata* breeds west of Pir Panjal range, the Ladakh population in the east belongs to *M. a. alboides* (Ali & Ripley, 1983). However, there were sporadic records of *M. a. personata* breeding east to Shushal (Chushul in Chang Thang?) according to Osmaston (Ibis, 1925:700). In our survey, all the birds seen were *M. a. alboides* and we did not encounter any *M. a. personata* [Probably because the potential localities north of Indus like Dah – Hanu, Spangmik, or Chushul were not surveyed]. It is also to be noted here that juveniles and many of the females of *M. a. alboides* do have greyish mantle, as of the adults of *M. a. personata*, warranting caution in identifying races. Nonetheless, future surveys should aim to identify the dividing line, the exact zone of hybridization in Ladakh.

Citrine Wagtail (*Motacilla citreola*):

The most common wagtail of Ladakh, breeding abundantly along rivers and large streams amidst Hippophae shrubs in the lower-belt (2750 - 3800 m) and Caragana bushes at higher elevations (4100 - 4750 m). Some of their breeding hotspots include wetlands of Shey (3500 m), Wakka Nallah stretch between Bodh Karbu and Mulbek (3400 - 3500 m), Tsarap riverbank, Padum (3600 m), Tso Kar (4600 m), and Rongo - Hanle stretch (4100 -4200 m).

Yellow Wagtail (*Motacilla flava*):

Less common than White or Citrine Wagtails, Yellow Wagtails were invariably seen about damp grassy patches near camping sites, and moist grazing pastures; usually not more than two or three individuals at a site. Barring one sighting from Lamayuru (3580 m) on 2-7-2000, all our records were from higher altitudes (4100 – 4600 m). Regularly seen foraging in wet turf-grass country along Suru river between Penzi La base (4100 m) and Rangdum (4200 m). Also frequently seen in Tso Kar (4600 m) in small numbers.

Grey Wagtail (*Motacilla cinerea*):

Occasionally seen along rocky mountain streams between 2800 m and 3750 m; more common in Lower stretches of Indus (between Upshi and Khaltse) and Suru valleys (between Kargil and Parkachik).

Robin Accentor (*Prunella rubeculoides*):

Breeding pairs were commonly met about Caragana bushes on marshy riverbeds, and wet grass-and-shrub banks of riverine backwaters; our records were from 4100 m to

4600 m, mostly from upper Suru valley around Rangdum, and Sumdo - Korzok stretch in Chang Thang. On 9-7-2000 at Sumdo, one bird (presumably ♂) was seen pecking the cloacal opening of its mate (♀?), a behaviour associated with promiscuous mating system and found commonly with Dunnocks (*P. modularis*) in Europe.

Brown Accentor (*Prunella fulvescens*):

Typically found in drier Caragana country, we recorded these accentors only from Rongo - Hanle stretch in Chang Thang (4150 - 4300 m); they were presumably nesting amidst the Caragana shrubs of dry riverbed along with *Phylloscopus griseolus*.

Fire-fronted Serin (*Serinus pusillus*):

Commonly seen about dry, scrub-covered rocky hill slopes, and the adjacent cultivation, from 2800 m (Sankoo) to 4200 m (Mahe bridge); the optimal range, however, seems to be between 3200 m and 3800 m. Along Indus valley, quite common between Khaltse and Chumathang, and rare beyond Mahe bridge; absent from Tso Kar - Sumdo - Tso Moriri. In Zaskar, regularly seen between Panikhar and Rangdum, though found only in small numbers around Padum. Roosts in small flocks in young Salix plantations, invariably with House Sparrows. No nesting activity observed till the middle of July.

European Goldfinch (*Carduelis carduelis*):

Seen occasionally in a mixed landscape of Hippophae scrub country interspersed with old poplar and willow trees; recorded in our survey from Suru valley (between Kargil and Tangole, 2800 - 3450 m) and along Wakka nallah stretch (between Kargil and Mulbek, 2800 - 3430 m); PS saw an individual at Padum (3610 m) in Zaskar on 27-6-2000. Most of the sightings were of pairs.

Twite (*Carduelis flavirostris*):

A characteristic species of high-altitude Tibetan steppe country and found breeding from 3800 m to 4600 m; Except one pair at Fotu La (3800 m) on 24-6-2000, all our sightings were from the tablelands of Tso Kar and Tso Moriri (4600 m), and Caragana country between Rongo and Hanle (4150 - 4300 m); very common wherever they were seen. Its strong affinity for arid facies in the breeding season probably accounts for its absence from Zaskar. In this season, both Twite and its close-looking cousin Plain Mountain Finch (*Leucosticte nemoricola*) seem to be mutually exclusive in their distribution ranges except along the interface (e.g., Fotu La and Sumdo); [Holmes (1986) quoted a couple of old sighting records of Twites from Rangdum area in Zaskar; probably a mistaken identity?].

Plain Mountain Finch (*Leucosticte nemoricola*):

One of the most common finches of Ladakh, often found in association with Brandt's Mountain Finches (*L. brandti*); in summer, both occur in barren mountain slopes, scree, and alpine pasture lands, usually away from cultivation. Our records were between 3400 m and 4450 m. As stated earlier, seems to have exclusive distribution

pattern vis-à-vis Twites [though found together in places like Fotu La and Sumdo]. Abundant in both upper Suru and Zanskar valleys, and common along the turf-grass riverbed between Meru and Gya; found in small isolated pockets along the Indus valley. Absent from high-altitude tablelands of Rupshu and Chang Thang where Twites were predominant. In Zanskar, solitary individuals were often seen foraging along the stony edges of mountain-streams, in association with White-breasted Dippers.

Brandt's Mountain Finch (*Leucosticte brandti*):

A close associate of Plain Mountain Finches, Brandt's were commonly seen in Zanskar around Zuildo – Rangdum – Penzi La stretch (3950 – 4200 m) and along Phey -Padum – Thondhe (3500 – 3600 m); also found sympatric with *L. nemoricola* between Meru and Gya (3780 – 4100 m). Along with Twites and Horned Larks, abundant in high-altitude plateaus of Tso Kar and Tso Moriri (4600 m), and foot of Sumdo ridge (4450 m). However, we did not have any sightings from Indus valley.

Common Rosefinch (*Carpodacus erythrinus*):

Ubiquitous about shrub-covered rocky slopes, scrub-and-bush country, young *Salix* plantations, and cultivation (especially standing crop-fields of Pea) across Ladakh from 3050 m (Trespone near Kargil) up to 4300 (near Penzi La). Absent from Rupshu and Chang Thang areas above 4200 m, where *C. rubicilla* and *C. rubicilloides* were common. Often seen foraging in freshly-sown wheat fields, close to *Salix* trees in Indus valley.

Streaked Rosefinch (*Carpodacus rubicilloides*):

Commonly breeds amidst *Caragana* and *Rosa* shrubs in Tibetan steppe country above 4200 m, often in sympatry with Great Rosefinch (*C. rubicilla*). Most of our records were from Tso Kar – Sumdo – Korzok stretch (4450 – 4600 m) and Mahe bridge – Nyoma – Hanle (4100 – 4300 m); also occasionally seen between Chumathang and Mahe bridge (3800 – 4150 m) on 7-7-2000. As Twites, its affinity for arid biotope may be the reason for its absence from Zanskar.

Great Rosefinch (*Carpodacus rubicilla*):

Though often found in association with Streaked Rosefinches, *C. rubicilla* had a wider altitudinal range of breeding (3550 – 4600 m) and seemed to have a broader optimum on moisture-gradient. In addition to eastern Ladakh where it was found in sympatry with *C. rubicilloides*, we had a couple of records from Indus valley (Leh – Upshi, 3500 - 3600 m, on 17-6-2000 & 14-7-2000). In Zanskar, a good breeding population was found along Zuildo – Rangdum – Penzi La base (3950 – 4300 m) in the last week of June; a significant finding in view of the fact that old breeding records of *C. rubicilla* in Zanskar had been questioned by Holmes (1986).

Rock Bunting (*Emberiza cia*):

A familiar bird of rocky hillsides, stony uplands planted with *Salix*, and the adjacent cultivation; recorded in the survey from 2950 m (Lankerchey, near Kargil on 1-7-2000) up to 3800 m (near Rangdum, on 25-6-2000). Apart from Suru valley, regularly seen breeding amidst *Hippophae* scrub along Tsarap riverbank near Padum (3600 m) by the end of June. Occasionally seen along the Indus valley, especially between Leh and Mahe bridge (3550 – 4100 m).

7.7 Ecological Segregation of Some Selected Sister-Taxa

The avifauna of Ladakh, at the landscape level, is marked with sympatric occurrence of several sets of closely-related bird species; for example, three species of *Corvus* crows, four species of *Motacilla* wagtails, and three species of *Phylloscopus* warblers, breed within Ladakh. The question as to how they co-exist requires us to examine the factors that act to minimize competition among the sympatric species. Based on our landscape analysis of bird distribution in Ladakh during the autumn survey in 1999 [see the Technical Report of HBD Project for 1998-99], We identified such potential mechanisms of ecological segregation in several avian sister-taxa; *the propositions are, however, speculative and need to be investigated for further corroboration*. These factors can be projected in a functionally hierarchical set-up as follows; in other words, the segregation can be explained in terms of the following mechanisms in top-down manner:

- ◆ **Altitude:** Isolation through differences in altitudinal ranges within which the species breed.
- ◆ **Landscape Unit:** If there is a high degree of overlap in the optimal altitudinal range, then the species may well be spatially segregated through historical forces. Such a segregation often manifests in a gradient of abundance rather than in absolute terms of presence or absence.
- ◆ **Habitat:** The final level of isolation operates with respect to habitat requirements or 'habitat niche parameters'; these species occupy the same altitudinal ranges and landscape units, but have non-overlapping habitat signatures. [Strictly speaking, these taxa are referred to by the term 'sympatric species'].
- ◆ **Sister taxa**

Swifts: *Apus apus* has a wider range of elevational occupancy, while *Apus pacificus* breeds in a narrow belt within this range (see Fig. 1). It is to be noted here that *A. apus* predominantly forages over the waters of mountain rivers and *A. pacificus* sallies around the ridge tops, often away from rivers.

Pigeons: *Columba livia* is separated from its congeners mainly by the altitude (see Fig. 2); though *C. livia* and *Streptopelia orientalis* do have overlapping altitudinal ranges, they differ in their habitats – cliffs and wooded compounds respectively. Similarly, *C. rupestris* and *C. leuconota* differ vis-à-vis habitat requirements – the former breeds in rocky cliffs and snow-clad ridge tops in case of the latter. The climatology of the landscape units also play a role in the distribution patterns of *C. leuconota*; e.g., the higher precipitation rate (snowfall) of Zaskar predisposes occurrence of a good population of *C. leuconota*.

Choughs: Both *Pyrrhocorax pyrrhocorax* and *P. graculus* (Fig. 3) occupy almost same altitudinal ranges (though the optimal zone is understandably higher for *P. graculus*). As stated elsewhere in the report, they seem to have a strikingly different foraging behaviour wherever they are sympatric; while the Red-billed probes ground for food often away from the villages, the Yellow-billed acts as the scavenger hanging around human habitations. The different bill shapes of these two choughs may be an evolutionary response to such behaviour.

Corvids: All the three species of *Corvus* show evident altitudinal segregation (Fig. 4). The small overlapping zone between *C. corone* and *C. corax* is actually the case of differentiation through exclusiveness of landscape units.

Rubythroat & Bluethroat: As seen in Fig. 5, both the species of *Luscinia* chats exhibit a remarkable instance of altitudinal segregation [they also have different habitat-signature, a function of altitude].

Redstarts: Of the three species, *Chaimarornis leucocephalus* occupies an exclusive habitat niche of rocky streams and rivers while the other two redstarts of the genus *Phoenicurus* are inhabitants of ridges and foothills. *P. erythrogaster* breeds essentially at higher altitudes, and *P. ochruros* is rarer at these belts (Fig. 6).

Wheatears: The commonest wheatear of Ladakh, *Oenanthe deserti*, occurs above 3200 m; the other two species are less common and are found below 3200 m (Fig. 7). Among these two, while *O. pleschanka* breeds regularly along Lower Suru valley, *O. picata* is more common along Lower Indus valley.

Warblers: As seen in Fig. 8, *Phylloscopus affinis* is found at higher elevations and *Sylvia curruca* occupies a narrow range at lower belt. *P. sindianus*, the commonest warbler, has a wider distribution and *P. griseolus* is found at mid-altitudes. The issue of altitudinal overlaps amongst the four warbler species seem to have resolved by their habitat signatures: *P. sindianus* – young salyx / poplar groves and *Hippophae* scrubs, *S. curruca* – *Hippophae* scrubs close to streams, *P. griseolus* – scrub-covered rocky hillsides, and *P. affinis* – high altitude *Caragana* bushes.

Wagtails: The isolation mechanisms among the four breeding species of wagtails in Ladakh are not clearly understood as our observations are rather limited for *Motacilla flava*. However, *M. cinerea* and *M. alba* are altitudinally overlapping (Fig. 9) and differ in their preferred habitats – rocky mountain streams are favoured by Grey Wagtail and other waterbodies in general are frequented by White Wagtail. Though the range of *M. alba* also overlaps with that of *M. citreola*, *M. alba* are generally scarcer above 3700 m; further, *M. citreola* is invariably restricted to *Hippophae* scrubs and *Caragana* bushes along streams and rivers, and *M. alba* is often found along dykes.

Finches: *Carduelis carduelis* and *C. flavirostris* have disjunct ranges along the elevational gradient (Fig. 10), the middle being usurped by *Serinus pusillus* [They also show evident signs of habitat differentiation]. The two mountain finches *Leucosticte nemoricola* and *L. brandti* occupy same altitudinal range; curious enough, they also seem to share similar habitat type and are found together in most of the localities. Further meticulous observations are required to ascertain the actual mechanisms of ecological separation between them.

Rosefinches: Among the three common rosefinches of Ladakh, *Carpodacus erythrinus* inhabits lower elevations while the other two species occur in higher altitudes (Fig. 11). The high-ranging species (*C. rubicilla* and *C. rubicilloides*) often breed in the same habitat and area, and we do not know how they co-exist with minimal competition; probably, their food habits may give clue to such mechanism.

Fig. 1 Swifts

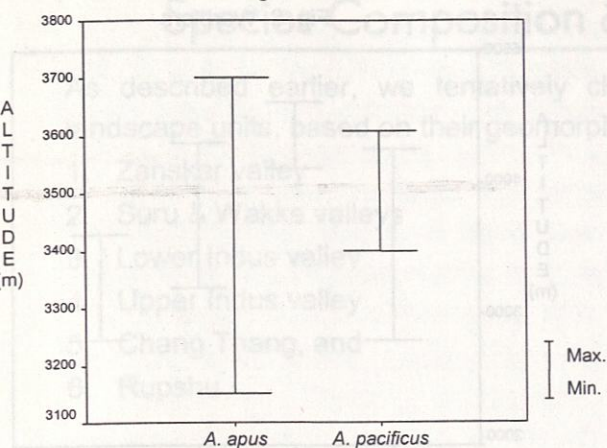


Fig. 2 Pigeons

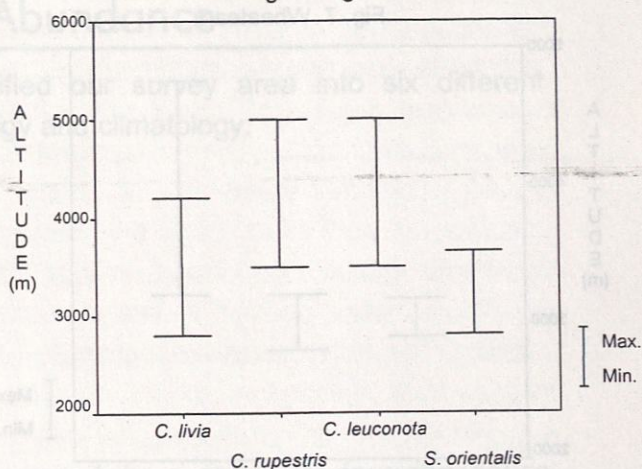


Fig. 3 Choughs

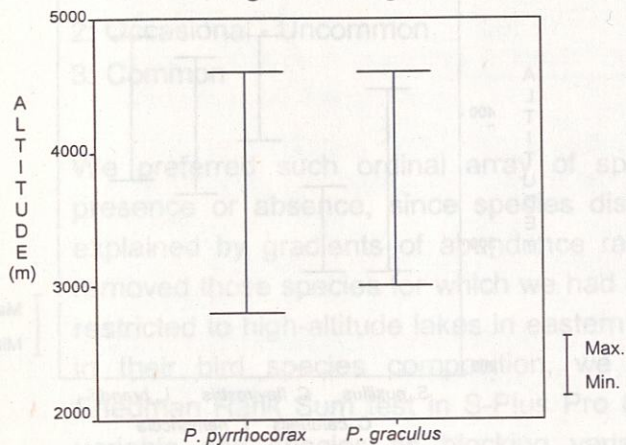


Fig. 4 Corvids

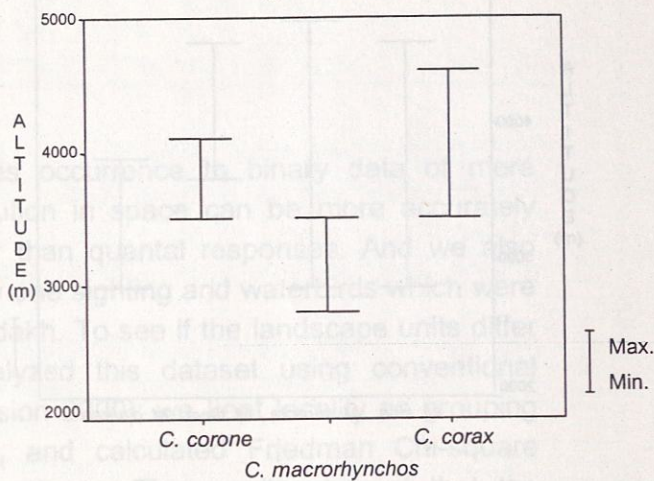


Fig. 5 Rubythroat &

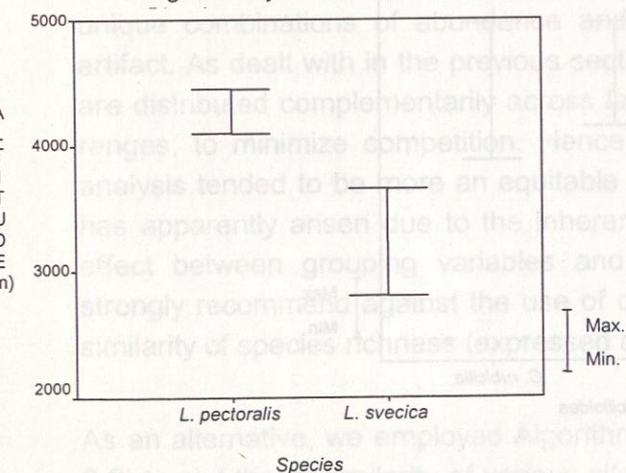


Fig. 6 Redstarts

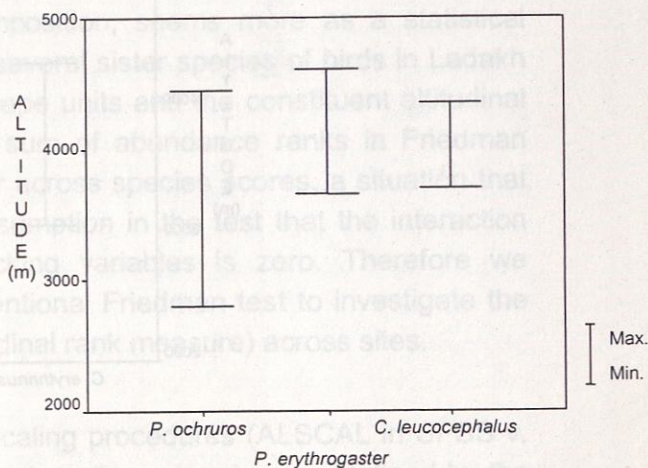


Fig. 7 Wheatears

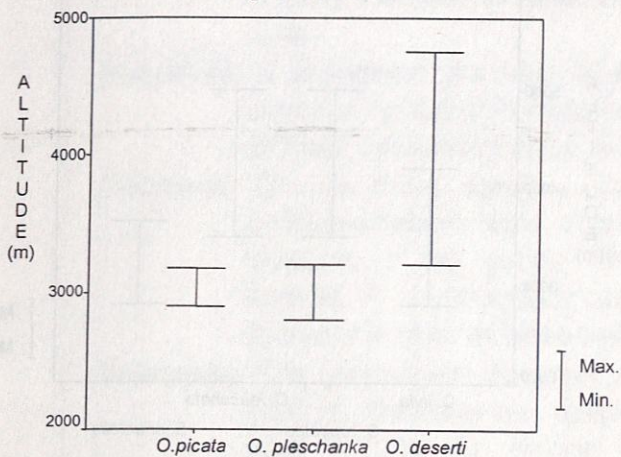


Fig. 8 Warblers

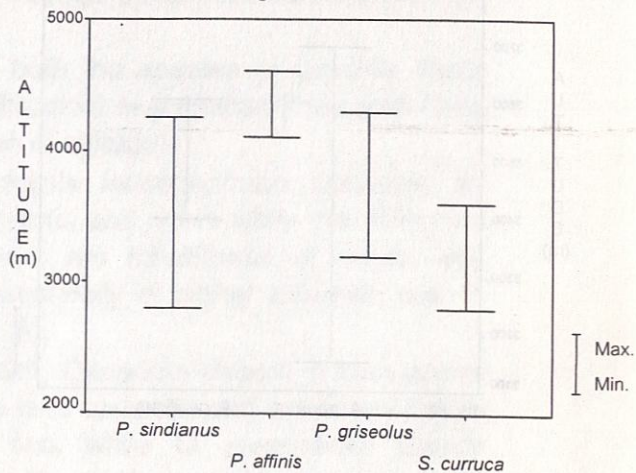


Fig. 9 Wagtails

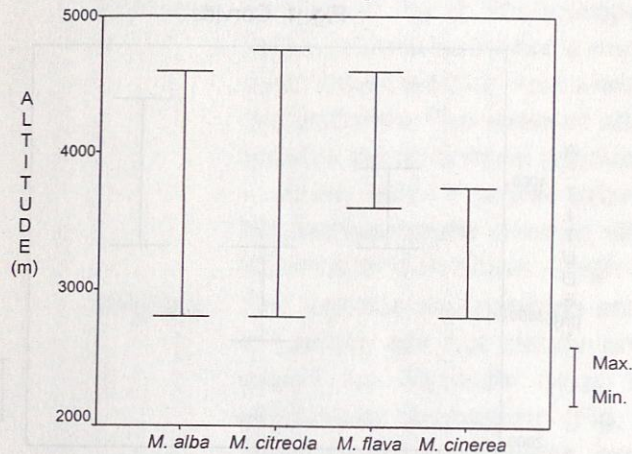


Fig. 10

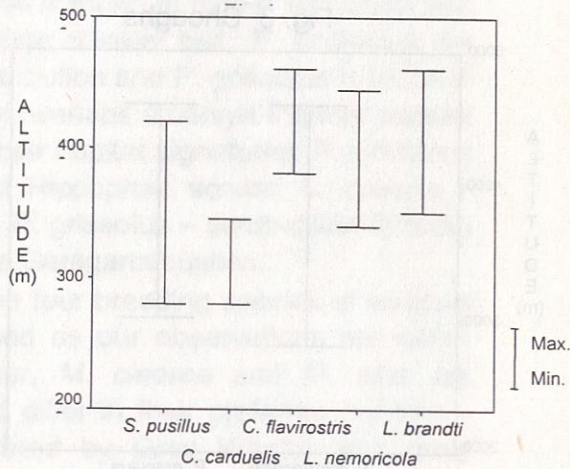
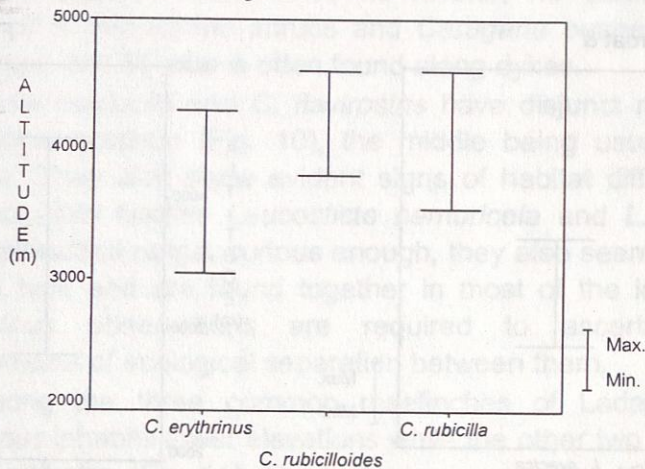


Fig. 11 Rosefinches



7.8 Similarity of Landscape Units in Their Bird Species Composition & Abundance

As described earlier, we tentatively classified our survey area into six different landscape units, based on their geomorphology and climatology:

1. Zanskar valley
2. Suru & Wakka valleys
3. Lower Indus valley
4. Upper Indus valley
5. Chang Thang, and
6. Rupshu

We examined all our sighting records and grouped the species into four abundance classes with scores in each landscape unit:

0: Absent

1: Rare

2: Occasional - Uncommon

3: Common

We preferred such ordinal array of species occurrence to binary data of mere presence or absence, since species distribution in space can be more accurately explained by gradients of abundance rather than quantal responses. And we also removed those species for which we had only one sighting and waterbirds which were restricted to high-altitude lakes in eastern Ladakh. To see if the landscape units differ in their bird species composition, we analyzed this dataset using conventional Friedman Rank Sum test in S-Plus Pro (version 2000); we kept locality as grouping variable and species as blocking variable, and calculated Friedman Chi-square parameter for the ordinal data of bird abundance. The results showed that the landscape units did not differ significantly ($\chi^2 = 8.12$, $df = 5$, $p = 0.149$). This conclusion, despite the fact that each landscape unit in Ladakh is characterized by unique combinations of abundance and composition, seems more as a statistical artifact. As dealt with in the previous section, several sister species of birds in Ladakh are distributed complementarily across landscape units and the constituent altitudinal ranges, to minimize competition. Hence the sum of abundance ranks in Friedman analysis tended to be more an equitable affair across species scores, a situation that has apparently arisen due to the inherent assumption in the test that the interaction effect between grouping variables and blocking variables is zero. Therefore we strongly recommend against the use of conventional Friedman test to investigate the similarity of species richness (expressed as ordinal rank measure) across sites.

As an alternative, we employed Algorithmic Scaling procedures (ALSCAL in SPSS v. 8.0) to plot the dissimilarity of various sites in a two-dimensional space defined by the species abundance scores. We opted for Non-Metric Multi-dimensional Scaling (NMDS) as a) it is free of assumptions about the distribution of data, b) it includes

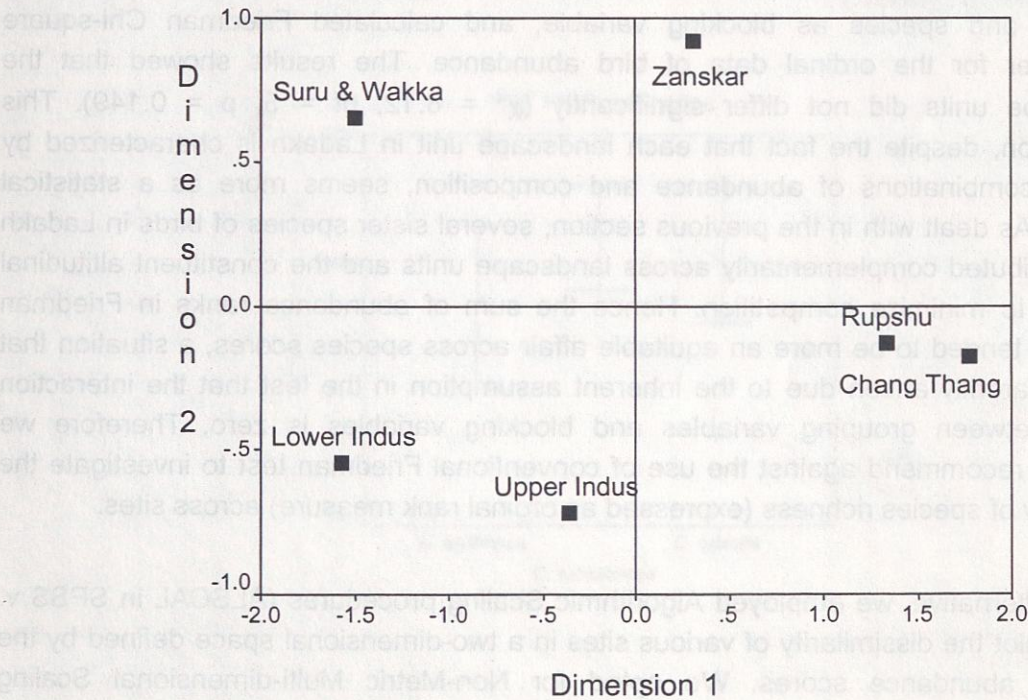
scale-specific models for ordinal data, c) the distances depicted on the configuration are analogous to ecological dissimilarities between the sites, and d) among all the ordination and scaling methods, NMDS has been known to do extremely well given the constraints and shortcomings of biological data (Rohlf, 1972). We ordered an asymmetrical dataset of [species X landscape unit], in which the abundance scores were on ordinal scale. Then, a symmetrical dissimilarity matrix was constructed using City Block distance measure ("Manhattan Distance") as Block distance enables us to calculate the sum of absolute differences between items measured on ordinal scale. Four iterations were performed until the minimum stress value became 0.005. Stimulus coordinates were derived in two dimensions with the final Young's Stress score of 0.00251. The coordinates were given in Table 1.

Table 1. Stimulus Coordinates of NMDS

Stimulus No.	Variable	Dimension 1	Dimension 2
1	Zanskar	0.312	0.919
2	Suru & Wakka	-1.491	0.655
3	Lower Indus	-1.573	-0.544
4	Upper Indus	-0.358	-0.721
5	Chang Thang	1.779	-0.180
6	Rupshu	1.332	-0.129

The NMDS configuration (see Fig. 12) categorically shows four distinct zones: Suru & Wakka nallah valleys, Zanskar valley, Upper & Lower Indus valleys, and Rupshu & Chang Thang areas. Hence future conservation planning in Ladakh can economize resources by aiming to increase the representativeness of each of these four zones.

Fig. 12 NMDS configuration showing the dissimilarity of landscape units in terms of bird abundance & composition



7.9 Significant Findings of The Survey

Though this survey was limited in time, several interesting records regarding distribution of birds in Ladakh and some disturbing observations that may pose threats to the mountain ecosystem in future have been documented:

- ◆ Chukar partridge has become extremely rare in Suru valley and Wakka Nallah stretch and in fact may become locally extinct in near future. Hunting by local people is strongly suspected to be the reason.
- ◆ Several new localities where Rock and Hill Pigeons breed sympatrically have been identified between 3500 - 4200.
- ◆ Long-tailed Shrike (*Lanius schach*), an invasive species, is feared to have replaced Grey-backed Shrike (*L. tephronotus*), a native of Ladakh, in Zaskar. Shrinkage in area of *Hippophae* scrub vegetation (the ideal habitat of Grey-backed Shrike) and expansion of sub-optimal farming practices leaving a large area of fallow lands gave rise to the invasion.
- ◆ Red-billed and Yellow-billed Choughs, where they are sympatric, show ecological isolation through differential foraging behaviour; the shapes of their bills do seem to have evolved in response to such ecological mechanism.
- ◆ First confirmed breeding records of Variable Wheatear (*Oenanthe picata*) in Ladakh have been made.
- ◆ The occurrence of Pale Martins (*Riparia diluta*) in Ladakh during summer has been confirmed; the birds that we sighted along Upper Indus valley were possibly breeding.
- ◆ Further summer record of the White-rumped Snowfinch (*Pyrgilauda taczanowskii*), possibly breeding in Fotu La.
- ◆ A good breeding population of Great Rosefinch (*C. rubicilla*) has been discovered in Zaskar; a significant finding in view of the fact that old breeding records of *C. rubicilla* in Zaskar had been questioned by Holmes (1986).
- ◆ We did not encounter any signs of breeding or occurrence of Large-billed Bush Warbler (*Bradypterus major*), a threatened native species of North-west Himalayas, in our survey. Locally extinct?
- ◆ Shrinking acreage of *Hippophae* scrub vegetation (by the expansion of agriculture) pose imminent threat to nesting of several native birds, that include Bluethroat, Lesser Whitethroat, Mountain Chiffchaff, and Grey-backed Shrike. We recommend that the practice of raising *Hippophae* as hedge plant in lieu of rubble-wall should be encouraged.
- ◆ The spread of poplar and *Salix* plantations along river valleys enables opportunistic and invasive species of birds to colonize and expand; for example, the population of non-native species like Oriental Turtle Dove, Long-tailed Shrike, Blue-capped Redstart, Brahminy Starling, Great Tit, and European Goldfinch are on the rise. We recommend that the Forest Department's plantation works should be limited to village-farms on a smaller scale [to meet the local wood requirements], and the efforts of both J & K Forest Department and the Wasteland Board to plant *Salix* all along the river valleys "in order to reclaim the barren landscape" should be put an end to.

References

- Ali, S. and S.D. Ripley, 1983.** Handbook of the Birds of India and Pakistan. Compact edition. Oxford Univ. Press, New Delhi.
- Chaurasia, O.P. and B. Singh, 1996.** *Cold Desert Plants*. Vol I-IV. Field Research Laboratory, DRDO, Leh.
- Chundawat, R.S. and G. S. Rawat, 1994.** Indian Cold Deserts: A status report on biodiversity. Wildlife Institute of India, Dehra Dun.
- Fox, J.L., C. Nurbu, S. Bhatt, and A. Chandola, 1994.** Wildlife Conservation and Land Use Changes in the Trans-Himalayan Region of Ladakh, India. *Mountain Res. Develop.*, 14:39-60.
- Gole, P. 1992.** On the trail of wintering Black-necked Cranes in India. *J. Ecol. Soc.*, 6:7-22
- Grimmett, R., C. Inskipp, and T. Inskipp, 1998.** *Birds of the Indian Subcontinent*. Oxford Univ. Press, Delhi.
- Holmes, P.R. 1986.** Avifauna of Suru river valley, Ladakh. *Forktail*, 2:21-41
- Kachroo, P., B.L. Sapru, and U. Dhar, 1977.** *Flora of Ladakh*. Bishen Singh Mahendra Pal Singh, Dehra Dun. 172 pp.
- LaPersonne, V.S. 1928.** A collecting trip to Ladak. *J. Bombay Nat. Hist. Soc.*, 32: 505-517, 650-659
- Ludlow, F. 1920.** Notes on the nidification of certain birds in Ladak. *J. Bombay Nat. Hist. Soc.*, 27:141-146
- Mallon, D.P. 1987.** The winter birds of Ladakh. *Forktail*, 3:27-41
- Mallon, D.P. 1989.** An ecological survey of the protected area network in Ladakh. Report to the Department of Wildlife Protection, Jammu & Kashmir Government, Srinagar. Unpublished. 13 pp.
- Narayan, G. 1987.** Black-necked Crane (*Grus nigricollis*) in Ladakh. *J. Bombay Nat. Hist. Soc.*, 83(S):180-195
- Osmaston, B.B. 1925.** The birds of Ladakh. *Ibis*, 12:663-719
- Pfister, O. 1997.** Introduction to the birds of Ladakh. Unpublished M.Sc. Dissertation. University of Hull, Hull.
- Pfister, O. 1998.** The Breeding Ecology and Conservation of the Black-necked Crane (*Grus nigricollis*) in Ladakh, India. Unpublished Doctorate Thesis, University of Hull, Hull.
- Rashid Raza et al., 1998.** Identify Potential Areas for Conserving Biodiversity in the Western Himalaya. Technical Report (1997-1998) of WII-USFWS Collaborative Project, Wildlife Institute of India, Dehra Dun.
- Rodgers, W. A and H. S. Panwar, 1988.** *Planning a Wildlife Protected Area Network in India. Vol.1 Report*. Wildlife Institute of India, Dehra Dun.
- Rohlf, F.J. 1972.** An empirical comparison of three ordination techniques in numerical taxonomy. *Syst. Zool.*, 21:271-280
- Wathen, M.L. 1923.** Ornithological notes from a trip in Ladak. *J. Bombay Nat. Hist. Soc.*, 29:694-702

Geographical Location of Survey Sites in Ladakh

SL. No.	Site Name	Locality	Altitude (m)	Latitude & Longitude
1	Fotu La		4100 m	N 34° 17' 26.1" E 76° 42' 07.4"
2	Gya	Rupshu	4100 m	N 33° 39' 07.0" E 77° 44' 19.7"
3	Hanle	Chang Thang	4288 m	N 32° 47' 07.3" E 79° 00' 14.7"
4	Kargil	Suru valley	2800 m	
5	Lamayuru	Lower Indus valley	3390 m	N 34° 17' 25.1" E 76° 47' 32.1"
6	Leh	Lower Indus valley	3500 m	N 34° 10' 19.6" E 77° 34' 42.4"
7	Likir	Lower Indus valley	3520 m	N 34° 15' 52.6" E 77° 12' 40.3"
8	Loma bridge	Upper Indus	4170 m	N 33° 10' 12.3" E 78° 49' 28.9"
9	Mahe bridge	Upper Indus	4150 m	N 33° 16' 09.3" E 78° 28' 15.5"
10	Manda	Zaskar	3700 m	N 33° 37' 36.4" E 76° 41' 36.0"
11	Meru	Rupshu	3780 m	N 33° 44' 09.6" E 77° 44' 45.2"
12	Mulbek	Wakka Nullah	3430 m	N 34° 22' 45.2" E 76° 22' 01.5"
13	Nimu	Lower Indus valley	3200 m	N 34° 11' 52.2" E 77° 20' 07.2"
14	Nyoma	Upper Indus	4210 m	N 33° 12' 08.0" E 78° 38' 59.9"
15	Padum	Zaskar	3610 m	N 33° 28' 11.6" E 76° 52' 45.7"
16	Panikhar	Suru valley	3400 m	N 34° 06' 16.0" E 75° 56' 49.5"
17	Penzi La	Zaskar	4550 m	N 33° 51' 55.3" E 76° 21' 33.5"
18	Penzi La glacier (base)	Zaskar	4100 m	N 33° 51' 05.7" E 76° 23' 18.8"
19	Rangdum	Zaskar	4150 m	N 34° 03' 17.5" E 76° 19' 38.8"
20	Rongo	Chang Thang	4200 m	N 33° 06' 42.9" E 78° 50' 13.4"
21	Rumtse	Rupshu	4320 m	N 33° 37' 34.6" E 77° 46' 04.1"
22	Sani	Zaskar	3580 m	N 33° 30' 18.5" E 76° 48' 42.9"
23	Sankar	Lower Indus valley	3600 m	N 34° 10' 50.1" E 77° 35' 33.0"
24	Sankoo	Suru valley	3150 m	N 34° 18' 16.6" E 75° 57' 46.2"

SL. No.	Site Name	Locality	Altitude (m)	Latitude & Longitude
25	Shibra	Zaskar	3800 m	N 33° 42' 41.0" E 76° 32' 16.7"
26	Sumdo	Chang Thang	4450 m	N 33° 14' 03.0" E 78° 22' 05.4"
27	Taglang La	Rupshu	5350 m	N 33° 30' 31.7" E 77° 46' 15.4"
28	Taru	Lower Indus valley	3550 m	N 34° 10' 58.8" E 77° 24' 09.7"
29	Thondhe	Zaskar	3450 m	N 33° 30' 33.4" E 76° 55' 53.9"
30	Trishul tank, Leh	Lower Indus valley	3500 m	N 34° 08' 14.3" E 77° 30' 20.1"
31	Tso Kar	Rupshu	4600 m	N 33° 19' 52.7" E 78° 02' 13.8"
32	Tso Moriri (Korzok)	Chang Thang	4580 m	N 32° 58' 09.9" E 78° 16' 22.5"
33	Upshi	Upper Indus valley	3600 m	N 33° 49' 49.5" E 77° 48' 58.0"
34	Wanla	Lower Indus valley	3260 m	N 34° 15' 33.6" E 76° 50' 13.6"

Status Survey of Large Mammals In Eastern Ladakh & Nubra

by Yash Veer Bhatnagar & Rinchen Wanchuk*

8.1 Introduction

Ladakh is home to a unique assemblage of large mammals that include 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 on a global scale (Table 1). Earlier studies have produced information on the distribution, status and ecology of snow leopard, bharal, Ladakh urial and ibex from Central Ladakh (Fox *et al.* 1991a, Mallon 1991, Chundawat 1992, Chundawat and Qureshi 1999). However, such information on the species from eastern Ladakh (Tibetan argali, Tibetan gazelle, kiang, chiru and wild yak) and Nubra (Ladakh urial and feral Bactrian camels) are lacking. Even the anecdotal information available regarding these species (Lydekker 1907, Burrard 1925, Stockley 1928, 1936, Ganher 1979, Ranjitsinh 1981, Fox *et al.* 1991a) suggests that most of them are patchily distributed in small populations and have little chance of long term survival. In spite of these warnings, no specific conservation efforts have yet been undertaken for these endangered species. There is thus an urgent need to assess the present status of these species and prioritize areas for conservation efforts. The present study thus aimed to bridge this gap, first based on a rapid survey, and subsequently, in the future, based on short but focused surveys to assess conservation options for critically endangered species.

Table 1: Large mammals of Ladakh along with their legal conservation status (local names given in parenthesis)

Species	Scientific Name	Indian Wildlife Protection Act 1972 (Schudule)	IUCN Category (CAMP Workshop Anon. 1998a)
Ungulates			
Siberian ibex (<i>Skin</i>)	<i>Capra ibex sibirica</i>	I	Vulnerable
Tibetan argali (<i>Nyan</i>)	<i>Ovis ammon hodgsoni</i>	I	Critical
Ladakh urial (<i>Shapo</i>)	<i>Ovis orientalis vignii</i>	I	Endangered
Bharal (<i>Knapo</i>)	<i>Pseudois nayaur</i>	I	Low Risk
Tibetan antelope (<i>Stosh</i> or <i>Chiru</i>)	<i>Pantholops hodgsoni</i>	I	Critical
Tibetan gazelle (<i>Gowa</i>)	<i>Procapra picticaudata</i>	I	Critical
Tibetan wild ass (<i>Kiang</i>)	<i>Equus kiang</i>	I	Vulnerable
Wild yak (<i>Dong</i>)	<i>Bos grunniens</i>	I	Critical
(Feral) Bactrian camel (<i>Nabung</i>)	<i>Camelus bactrianus</i>	-	--
Large carnivores			
Snow leopard (<i>Shan</i>)	<i>Uncia uncia</i>	I	Endangered
Lynx (<i>Eyi</i>)	<i>Lynx isabellina</i>	I	?
Tibetan wolf (<i>Shanku</i>)	<i>Canis lupus chanko</i>	I	Vulnerable
Wild dog (<i>Pharra</i>)	<i>Cuon alpinus laniger</i>	II	Critical
Red fox (<i>Vatse</i>)	<i>Vulpus vulpus</i>	II	Low Risk
Brown bear (<i>Denmo</i>)	<i>Ursus arctos</i>	I	Low Risk

*International Snow Leopard Trust, USA. Presently with Snow Leopard Conservancy, USA.

Most of the region surveyed has a substantial presence of the Indian Army and the Indo-Tibetan Border Police, who have in the past played, and can further play a crucial role in the monitoring and protection of wildlife in the region. The project has thus been undertaken in collaboration with the Indian Army, so that it could be sensitized to such a need and possibility and to utilize their network of facilities during the survey.

The objectives of the survey were to:

1. Collect baseline information on status, distribution and threats to the large mammal species in eastern Ladakh and Nubra
2. Produce a protocol for the future monitoring of these large mammal species.

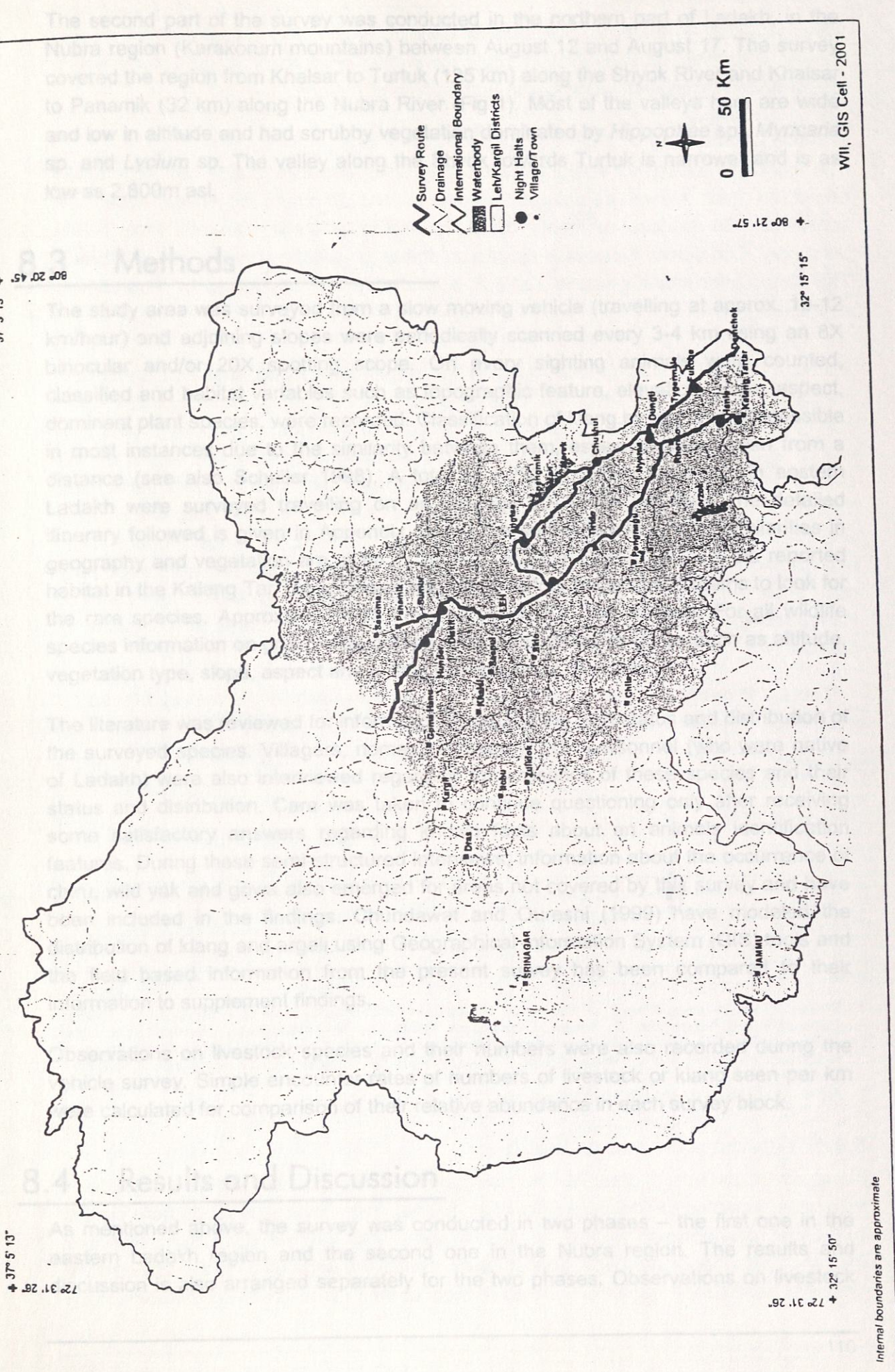
8.2 Study Area

The study was conducted in two regions of Ladakh (Fig 1). The first part of the study (21 July 2000 to 2 August 2000) was conducted in Eastern Ladakh (Changthang), from the Pongong Tso in the north, along the eastern border with Tibet, to Hanle in the south (Fig 1). The region mostly has rolling mountains interspersed with extensive plains where the minimum altitude is c. 4000m. There were very few patches of rugged terrain in the region. The region largely had open steppe community with medium to sparse vegetation cover. The entire region has been divided into eight blocks based on overall similarity in terms of topography and vegetation (Table 2).

Table 2: Topography and general vegetation of the surveyed blocks

Block	Approx. Dist. Covered (km)	Topography	Vegetation
Kharu-Changla	60	Wide valleys, moderately steep slopes	Sparse <i>Artemisia</i> spp., <i>Caragana</i> sp.
Changla-Tangtse	21	Wide valleys, moderately steep slopes	Sparse <i>Artemisia</i> spp.
Parma Valley	54	Wide valley, moderately steep slopes	Relatively high vegetation cover dominated by sedge and grass in the valley bottom
Pongong Tso (South bank)	70	Wide, gradually sloping bank, flanked by rolling mountains	Sparse <i>Sedum</i> sp. Mostly, with occasional sedge-grass meadows in moist areas
Chushul-Tsagala-Loma	49	Very wide valley with almost flat plains, low rolling mountain slopes	Relatively high vegetation cover dominated by sedge and grass in the valley bottom, Sparse on slopes
Loma-Demchok (Upper Indus)	114	Wide river valley, rolling slopes with occasional outcrops	River often spread out into moist areas with sedge and grasses; <i>Caragana</i> often interspersed within such meadows; drier slopes mostly had sparse <i>Artemisia</i> – <i>Tenacetum-Sedum</i> sp.
Loma-Hanle	61	Wide river valley, rolling slopes with occasional outcrops	Moister parts of valley often had sedge and grasses; drier areas mostly had sparse <i>Artemisia</i> sp.
Hanle-Kalang ar Tar	40	Rolling mountains, high plateau	Valley dominated by <i>Tenacetum</i> ; plateau dominated by <i>Artemisia salsaloides</i> , <i>Sassuria</i> spp.

The region between Hanle and Chumur in southeastern Ladakh was to be studied, but could not be surveyed due to bad weather and very poor road conditions.



Internal boundaries are approximate

WII, GIS Cell - 2001

The second part of the survey was conducted in the northern part of Ladakh, in the Nubra region (Karakorum mountains) between August 12 and August 17. The survey covered the region from Khalsar to Turtuk (125 km) along the Shyok River and Khalsar to Panamik (32 km) along the Nubra River (Fig 1). Most of the valleys here are wide and low in altitude and had scrubby vegetation dominated by *Hippophae* sp., *Myricaria* sp. and *Lycium* sp. The valley along the Shyok towards Turtuk is narrower and is as low as 2,800m asl.

8.3 Methods

The study area was surveyed from a slow moving vehicle (travelling at approx. 10-12 km/hour) and adjoining slopes were periodically scanned every 3-4 km using an 8X binocular and/or 20X spotting scope. On every sighting animals were counted, classified and habitat variables such as topographic feature, elevation, slope, aspect, dominant plant species, were recorded. Classification of kiang by sex was not possible in most instances due to the similarity between them, especially when seen from a distance (see also Schaller 1998). A total of 1,232-km along the roads in eastern Ladakh were surveyed travelling on an average 60-70 km per day. The detailed itinerary followed is given in Appendix 1, and the survey blocks as per similarities in geography and vegetation are given in Table 2. For the Tibetan gazelle, the reported habitat in the Kalang Tar Tar area was walked for c. four hours in two teams to look for the rare species. Approximately 15 km was covered in the process. For all wildlife species information on group size, composition, and habitat variables such as altitude, vegetation type, slope, aspect and terrain features were recorded.

The literature was reviewed for information regarding the past status and distribution of the surveyed species. Villagers, nomads and army/ITBP personnel (who were native of Ladakh) were also interviewed regarding the presence of these species and their status and distribution. Care was taken to continue questioning only after receiving some satisfactory answers regarding known facts about an animals identification features. During these semi-structured interviews, information about the occurrence of chiru, wild yak and gowa also emerged for areas not covered by this survey and have been included in the findings. Chundawat and Qureshi (1999) have modeled the distribution of kiang and argali using Geographical Information System (GIS) tools and the field based information from the present survey has been compared to their information to supplement findings.

Observations on livestock species and their numbers were also recorded during the vehicle survey. Simple encounter rates of numbers of livestock or kiang seen per km were calculated for comparison of their relative abundance in each survey block.

8.4 Results and Discussion

As mentioned above, the survey was conducted in two phases – the first one in the eastern Ladakh region and the second one in the Nubra region. The results and discussion is also arranged separately for the two phases. Observations on livestock

were restricted primarily to the eastern Ladakh region and are presented in this section. A section on conservation implications and recommendations is provided at the end covering aspects dealing with both surveyed regions.

Eastern Ladakh

The sightings, except for kiang, were too few to assess their status and distribution based on hard evidence, however, useful inferences could be made based on interviews with the local residents, the Army and Indo-Tibetan Border Police (ITBP) personnel. The survey block wise reports on status have been summarized in Table 3. The status information given in Table 3 is indicative and not based on quantitative estimates.

The most common wild animal found in the region was kiang, that had an almost continuous distribution along the valleys south from Tangtse. Other species seen during the survey were the Tibetan argali, bharal and the Tibetan gazelle. Bharal was widely distributed and was reported to occur in relatively good measure. Argali, on the other hand, in spite of being widely distributed was very rare in most parts. The Tibetan gazelle occurred in a very small region near Hanle, and there were unconfirmed reports from three other regions. All predators, viz. snow leopard, wolf, lynx and wild dog were uncommon in the entire range, and the last two were especially rare. Snow leopards were reported to be absent from the rolling slopes from Loma to Hanle and in Chumur. Each species is discussed in greater detail in the following sections.

Table 3 Presence and status[^] of large mammal species in the survey blocks

Survey Block	Bharal	Tibetan Argali	Tibetan gazelle	Kiang	Chiru	Snow Leopard	Wolf	Wild dog	Lynx
Kharu-Changla	S					VR	VR	VR	VR
Changla-Tangtse	S	VR				VR	VR	VR	VR
Parma Valley	M	VR		R		VR	S	VR	VR
Pongong Tso (S bank)	S	VR		R		VR	R	VR	VR
Pongong Tso (N bank-Phobrang)*	NC	S(la)		S		VR	R	VR	VR
Changchenmo*	NC	S		S	R	NC	R	VR	NC
Dauletbeg Oldi*	NC	NC		S	R	NC	R	VR	NC
Chushul-Loma	S	VR	NC	S(la)		VR	R	VR	VR
Loma-Demchok	S	R(la)	NC	M		VR	R	R	VR
Loma-Hanle	R	VR	VR	S			R	VR	VR
Kalang Tar Tar Valley		VR	VR	M			R	VR	VR
Chumur*	NC	S(la)	NC	M	NC		R	VR	VR

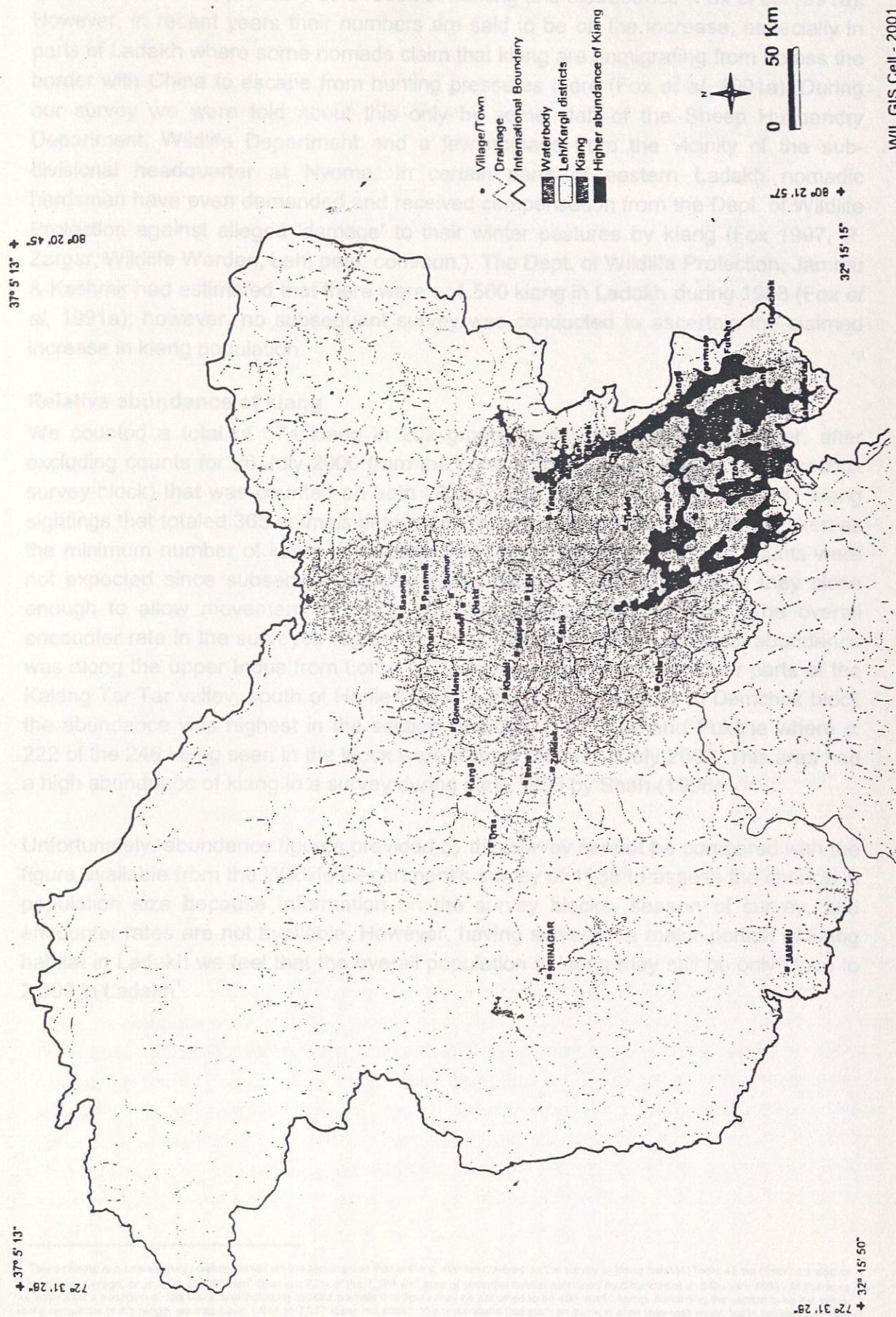
[^] Definitions: **VR**: very rare & small and fragmented populations (<50 only for herbivores); **R**: Small (51-100 only for herbivores) and fragmented; **S**: Small but continuous distribution; **M**: Many, locally abundant, continuous distribution; **NC**: Not clear – unconfirmed reports **Blank**: absent. **la** within parenthesis along with any category indicates that irrespective of any status information given, they may be locally abundant in a small part of the survey block

* Areas not physically covered during present survey

8.4.1 Tibetan wild ass or kiang

Kiang are inhabitants of open flat and rolling plains and occur all along eastern Ladakh from valley bottoms to ridgelines (Fox *et al.* 1991a). The distribution range here covers 6,000 km² according to Fox *et al.* 1991a and 7,388 km² as per Chundawat and Qureshi 1998 (Fig 2). Although quite common during the earlier part of the 20th century (Stockley 1936), their numbers declined in most of their range following the aggression

FIG. 7: Distribution of Kiang in Ladakh showing areas of higher abundance



Internal boundaries are approximate
Base map of distribution based on Chundawat and Qureshi 1999

with China in 1962, probably as a result of hunting and disturbance (Fox *et al.* 1991a). However, in recent years their numbers are said to be on the increase, especially in parts of Ladakh where some nomads claim that kiang are immigrating from across the border with China to escape from hunting pressures there (Fox *et al.* 1991a). During our survey we were told about this only by some staff of the Sheep Husbandry Department, Wildlife Department and a few nomads from the vicinity of the subdivisional headquarter at Nyoma. In certain parts of eastern Ladakh nomadic herdsman have even demanded and received compensation from the Dept. of Wildlife Protection against alleged 'damage' to their winter pastures by kiang (Fox 1997, R. Zargar, Wildlife Warden, Leh, pers. commun.). The Dept. of Wildlife Protection, Jammu & Kashmir had estimated that there were c. 1,500 kiang in Ladakh during 1988 (Fox *et al.* 1991a), however, no subsequent survey was conducted to ascertain the claimed increase in kiang population.

Relative abundance of kiang

We counted a total of 574 kiang in 202 groups during the survey. However, after excluding counts for 26 July 2000 from the Loma-Tygermale stretch (Loma-Demchok survey block) that was counted on both 26 July and 28 July 2000, we had 181 kiang sightings that totaled 365 animals detailed in Table 4 below. This can thus be taken as the minimum number of kiang in the surveyed part of Ladakh as double counts were not expected since subsequent survey routes did not overlap, nor were they close enough to allow movement by kiang that had already been counted. The overall encounter rate in the surveyed region was 0.92 kiang/km, and the highest abundance was along the upper Indus from Loma to Demchok followed by the upper parts of the Kalang Tar Tar valley, south of Hanle (Table 4, Fig 2). In the Loma to Demchok block the abundance was highest in the section between Tygermale and Fukche where c. 222 of the 246 kiang seen in the block were sighted on the 28 July 2000. This area had a high abundance of kiang in a survey during June 1995 by Shah (1996).

Unfortunately, abundance figures provided by this survey cannot be compared with the figure available from the Wildlife Department's survey of 1988 to assess the change in population size because information on the survey blocks, season of survey, and encounter rates are not available. However, having surveyed a major portion of kiang habitat in Ladakh we feel that the overall population of kiang may still be only close to 2,000 in Ladakh¹.

¹ This estimate is a coarse extrapolation based on the assumption that in the c. 400 km covered by the survey in kiang habitat (Table 4), we covered a strip of 4 km on an average, or an area of 1,600 km² (that is c.22% of the 7,388 km² area of potential habitat estimated by Chundawat and Qureshi 1999). In this area we estimated a minimum of 365 kiang and including missed animals this figure may be assumed to be 400 to 450 kiang. Assuming the pattern to be the same in the remainder of the range, we may have 1,847 to 2,077 kiang in Ladakh. We understand that such an extrapolation may lack merit, but is the best possible comparison with the available figure from the Wildlife Dept. of 1,500 kiang based on Fox *et al.* 1991a.

Table 4 Kiang encounter rates in the surveyed region in the eastern parts of Ladakh (Please see table 2 for a general description of habitats in the region)

Survey Block	Approx. Distance (Km)	No. Kiang	Kiang Enc. @ (Nos./Km)
Loma-Demchok (Indus)	114	249	2.18
Kalang Tar Tar Valley	40	69	1.73
Chushul-Loma	49	19	0.39
Parma Valley	54	9	0.17
Loma-Hanle	61	9	0.15
Pongong Tso	70	10	0.14
Total	398	365	0.92

Further information regarding kiang group size and habitat use was collected and has been presented in Appendix 2.

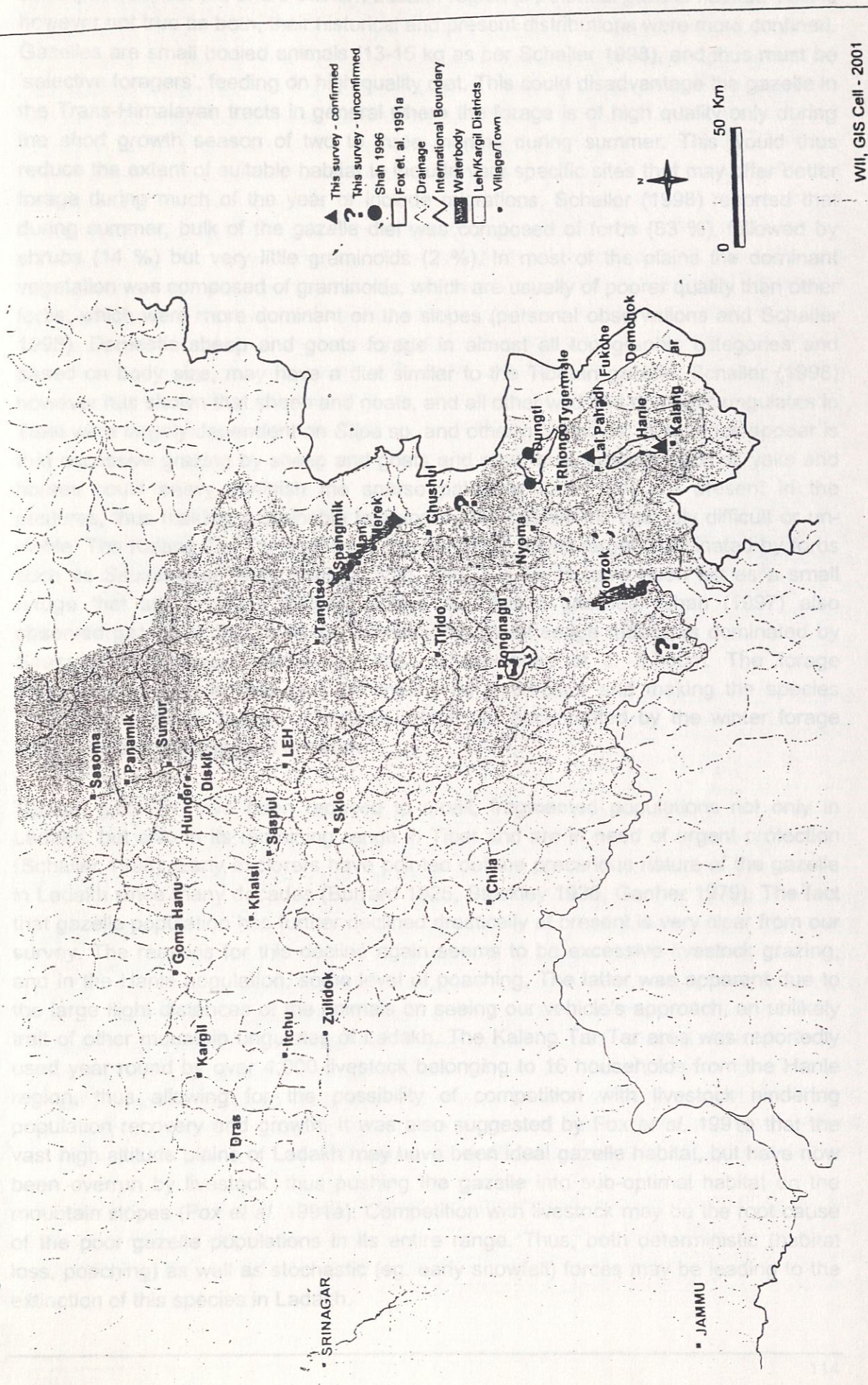
8.4.2 Tibetan gazelle or Gowa

Tibetan gazelles prefer open, rolling slopes or plains (Fox *et al.* 1991a) or alpine meadow and alpine steppe communities in broad valleys and high ridges (Schaller 1998). About 70 years ago they were widespread in the Rupshu and Hanle regions of Ladakh (Stockley 1936) but in the late 1980's only c. 50 gowa were estimated in a range of c. 1000 km² in this region in four distinct populations (Fox *et al.* 1991a). Chundawat and Qureshi (1999) estimated 40-50 gazelle in the largest known population in the Kalang Tar Tar plateau south of Hanle in 1996 and further estimated c. 70-80 gazelle in the entire Ladakh region. We were able to spot only four males in the Kalang Tar Tar area after a major search. Nomads reckon that the population in this region may not exceed 20 at present and the same would be the case in the population near Lal Pahari, north of Hanle. These may be the only remaining populations of the species in the entire Ladakh region with a coverage of < 100 km² (Fig 3). Nomads from Hanle felt that the primary cause of the gazelle's recent decline was the heavy early snows during October 1998 that was followed by a severe winter and heavy wolf predation of the already weakened animals.

Two other populations were reported in the recent past along the upper Indus valley near Dungti and around the Tso Kar Lake further west of Hanle (Fox *et al.* 1991a), however, we found that these populations do not occur at present. Interviews with personnel from the Ladakh Scouts, ITBP and some nomads suggest that a small population of the gazelle may exist near Chumur and another one near Chushul (Fig 3), but these reports need to be substantiated. One of our team members (Hav. Naseem Khan) said that he saw an animal that could be best described as a gazelle in the plains southeast of Chushul, but we could not confirm it. There had been some reports of isolated sightings of the gazelle near Loma and Dungti (Fig 3) by ITBP personnel during 1995 (Shah 1996), but we didn't get any such report during our surveys.

Little is known about gazelle's habitat requirements except that they are animals of the high alpine plains and rolling slopes (Fox *et al.* 1991a, Schaller 1998). By this

Fig. 3 : Distribution of the Tibetan gazelle in Ladakh based on this study and



WII, GIS Cell - 2001

Internal boundaries are approximate

description almost the entire eastern Ladakh region is potential gazelle habitat. This is however not true as both, their historical and present distributions were more confined. Gazelles are small bodied animals (13-15 kg as per Schaller 1998), and thus must be 'selective foragers', feeding on high quality diet. This could disadvantage the gazelle in the Trans-Himalayan tracts in general where the forage is of high quality only during the short growth season of two to three months during summer. This would thus reduce the extent of suitable habitat to include very specific sites that may offer better forage during much of the year or include migrations. Schaller (1998) reported that during summer, bulk of the gazelle diet was composed of forbs (83 %), followed by shrubs (14 %) but very little graminoids (2 %). In most of the plains the dominant vegetation was composed of graminoids, which are usually of poorer quality than other forbs, which were more dominant on the slopes (personal observations and Schaller 1998). Domestic sheep and goats forage in almost all topographic categories and based on body size, may have a diet similar to the Tibetan gazelle. Schaller (1998) however has shown that sheep and goats, and all other wild and domestic ungulates in Tibet were largely dependent on *Stipa* sp. and other graminoids. What does appear is that excessive grazing by sheep and goats and other bulk foragers such as yaks and horses could easily diminish the sparse palatable forbs that are present in the pastures, thus making sustainable foraging by the gazelle increasingly difficult or unviable. The Kalang Tar Tar plateau was different as it was largely dominated by forbs such as *Saussurea*, and *Leontopodium*, and thus could have been left as a small refuge that still provides suitable forage to Tibetan gazelles. Shah (1997) also observed gazelle in Sikkim to use primarily the moist sedge meadows dominated by *Saussurea*, *Kobresia* and *Carex* spp. at elevations of c. 5,300m. The forage preference of gazelle may thus be limiting its distribution and making the species highly vulnerable to human pressures, which are accentuated by the winter forage conditions and the vagaries of nature.

Tibetan gazelles have been reduced to small, fragmented populations not only in Ladakh, but also in its remaining range in Tibet and are in need of urgent protection (Schaller 1998). Early explorers have pointed out the precarious nature of the gazelle in Ladakh since many decades (Burrard 1925, Stockley 1936, Ganher 1979). The fact that gazelle population has further declined drastically at present is very clear from our survey. The reasons for this decline again seems to be excessive livestock grazing, and in the Hanle population, some level of poaching. The latter was apparent due to the large flight distances of the animals on seeing our vehicle's approach, an unlikely trait of other mountain ungulates of Ladakh. The Kalang Tar Tar area was reportedly used year round by over 4,000 livestock belonging to 16 households from the Hanle region, thus allowing for the possibility of competition with livestock hindering population recovery and growth. It was also suggested by Fox *et al.* 1991a that the vast high altitude plains of Ladakh may have been ideal gazelle habitat, but have now been overrun by livestock, thus pushing the gazelle into sub-optimal habitat on the mountain slopes (Fox *et al.* 1991a). Competition with livestock may be the root cause of the poor gazelle populations in its entire range. Thus, both deterministic (habitat loss, poaching) as well as stochastic (eg. early snowfall) forces may be leading to the extinction of this species in Ladakh.

Conservation measures are urgently needed in order to ensure the long-term survival of this species in Ladakh. These measures need to be a combination of authentic information generation and focussed conservation action. As a priority the existence of additional gazelle populations needs to be identified, and for the known populations, the population size, structure and immediate threats need to be assessed. We will conduct a survey to this effect during winter-spring of 2001. A strict ban on poaching and heavy reduction in livestock grazing (in carefully selected sites) needs to be imposed to enable the gazelle populations to recover and grow. Where ever possible linkages with local Non Government Organizations (NGO) dealing with conservation and education need to be established and collaborative action carried out. Since the community affected by a strict ban or reduction in livestock grazing will be nomads in the Hanle region, measures could be initiated to lease out the prime areas used by gazelle from them for a period of c. five years (See Anon. 2000 for an example of a similar effort by Mishra and Madhusudhan). This period can include assessment of alternative sites, where, based on similar efforts areas are procured and animals from the recovered populations are translocated. More on these aspects have been discussed in the concluding section of this report.

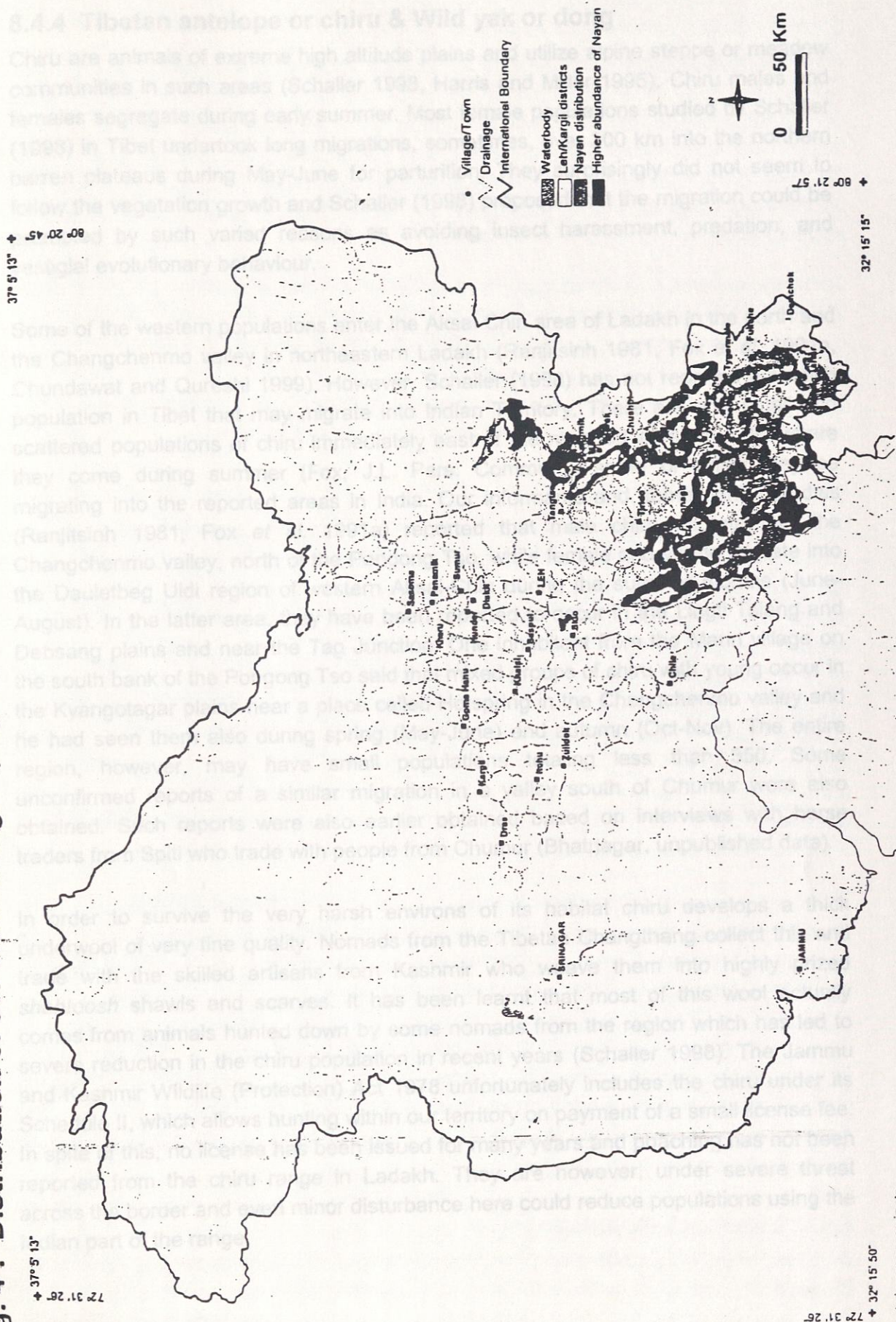
Within India, there is another small population of the gazelle in northern Sikkim (near Gyaum Chhona and Changri meadows) where Shah 1994 estimated approximately 60 animals. This population, although better than the present population in Ladakh, is not a very large one. The area is also immediately adjoining the border with Tibet. Pressure from livestock grazing was reported to be high, although there was no evidence of poaching.

8.4.3 Tibetan argali or nyan

Tibetan argali prefer open rolling slopes ($< 35^\circ$) at altitudes between 4,200 and 5,200m (Fox *et al.* 1991b, Schaller 1998, Namgial T., in prep). GIS modeling done by Chundawat and Qureshi (1999) suggested that they were widely distributed over c. 10,988 km² in eastern Ladakh (Fig 4) which is very similar to an older estimate of 10,000 km² by Fox *et al.* 1991a. Argali sightings were however, extremely rare in the region we surveyed. The only areas with relatively large populations of the species seem to exist in the Phobrang region in the north of the Pongong Tso (including Tsogtsalu, Bowa and Lunkar), in Tygermale along the northern bank of the upper Indus and in the Chumur region of southeastern Ladakh (Fig 4). A relatively large population also exists in the Khemmer catchment near Gya-Miru where there may be c. 75-90 argali of the 200 estimated for the entire Ladakh region (Fox *et al.* 1991a, Chundawat and Qureshi 1999). It was apparent from our survey that vast stretches of potential argali habitat were devoid of the species at present and the existing populations were localized and small, many of which could be unviable for long-term survival if serious conservation measures are not taken soon. During the survey we only had two argali sightings that totaled to five animals.

The highly fragmented population of argali in Ladakh may be due to heavy hunting of the rams during the past (Ward 1924, Ganhar 1979, Fox *et al.* 1991a) and the slow recovery extenuated due to habitat degradation caused by heavy livestock grazing pressures (see Section on livestock grazing below)

Fig. 4 : Distribution of the Tibetan argali (nayan) in Ladakh showing areas of higher abundance



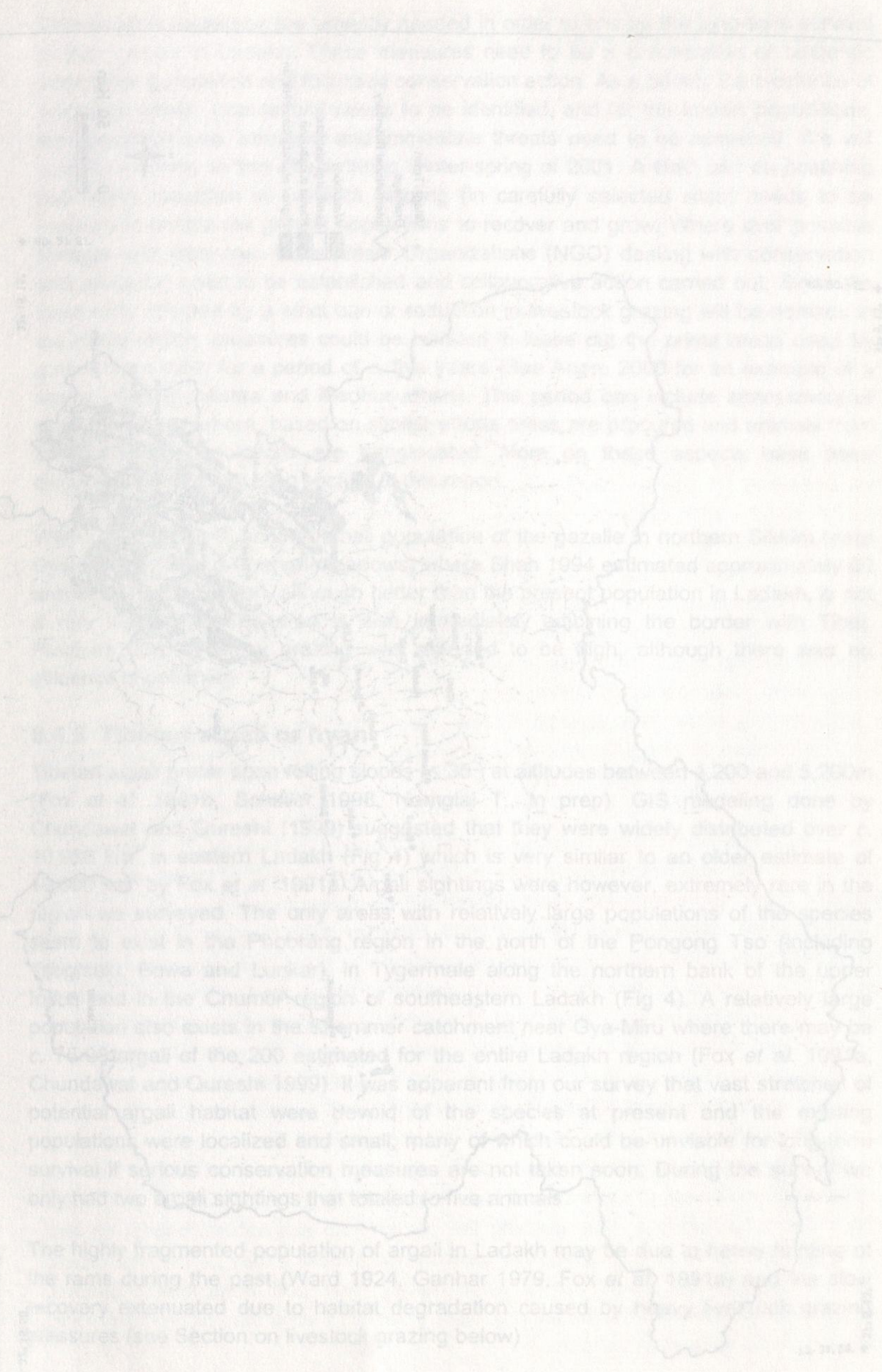


Fig. 4: Distribution of the Tibetan argali (*Naemorhedus tibetanus*) in Ladakh

The highly fragmented population of argali in Ladakh may be due to heavy hunting of the ram during the past (Ward 1924, Ganhar 1979, Fox *et al.* 1991a) and the slow recovery attenuated due to habitat degradation caused by heavy livestock grazing measures (see Section on livestock grazing below)

The highly fragmented population of the gazelle in northern Sikkim was estimated by Choudhury *et al.* (1994) to be approximately 1000 individuals. The population in Ladakh is estimated to be around 1000 individuals, although there are no reliable estimates.

3.4.3 Distribution of argali

Argali were found along the slopes of the Karakoram and Zaskar Range at altitudes between 1200 and 3300 m. Fox *et al.* (1991a) estimated the range of the species to be 1000-3000 m. Fox *et al.* (1991a) suggested that they were widely distributed over c. 1000 km² in eastern Ladakh (Fig. 4) which is very similar to an older estimate of 1000 km² by Fox *et al.* (1991a). Argali sightings were however, extremely rare in the regions surveyed. The only areas with relatively large populations of the species seem to exist in the Pongong Tso region in the north of the Pongong Tso (including Ngongso, Pawa and Dargun) in Tygermale along the northern bank of the upper Indus and in the Chumol region of southeastern Ladakh (Fig. 4). A relatively large population also exists in the Spiti catchment near Gya-Miru where there may be c. 1000 argali of the 200 estimated for the entire Ladakh region (Fox *et al.* 1991a, Choudhury and Qureshi 1999). It was apparent from our survey that vast stretches of potential argali habitat were devoid of the species at present and the existing populations were localized and small, many of which could be unstable for long-term survival if serious conservation measures are not taken soon. During the survey we only had two argali sightings that resulted in five animals.

The highly fragmented population of argali in Ladakh may be due to heavy hunting of the ram during the past (Ward 1924, Ganhar 1979, Fox *et al.* 1991a) and the slow recovery attenuated due to habitat degradation caused by heavy livestock grazing measures (see Section on livestock grazing below)

13-01-2000

8.4.4 Tibetan antelope or chiru & Wild yak or dong

Chiru are animals of extreme high altitude plains and utilize alpine steppe or meadow communities in such areas (Schaller 1998, Harris and Miller 1995). Chiru males and females segregate during early summer. Most female populations studied by Schaller (1998) in Tibet undertook long migrations, sometimes, over 300 km into the northern barren plateaus during May-June for parturition. They surprisingly did not seem to follow the vegetation growth and Schaller (1998) proposed that the migration could be prompted by such varied reasons as avoiding insect harassment, predation, and vestigial evolutionary behaviour.

Some of the western populations enter the Aksai Chin area of Ladakh in the north and the Changchenmo valley in northeastern Ladakh (Ranjitsinh 1981, Fox *et al.* 1991a, Chundawat and Qureshi 1999). However, Schaller (1998) has not reported any such population in Tibet that may migrate into Indian Territory. There are only small and scattered populations of chiru immediately east of the reported areas in India where they come during summer (Fox, J.L. Pers. Commun.), some of which may be migrating into the reported areas in India. Our informants and some earlier studies (Ranjitsinh 1981, Fox *et al.* 1991a) reported that male chiru migrate into the Changchenmo valley, north of the Pongong Tso, while female and young migrate into the Dauletbeg Uldi region of western Aksai-Chin during the summer months (June-August). In the latter area, they have been reported to occur in the Lingti Tsiang and Debsang plains and near the Tag Junction. One inhabitant from the Mann village on the south bank of the Pongong Tso said that mixed groups of chiru with young occur in the Kyangotagar plains near a place called Hotspring in the Changchenmo valley and he had seen them also during spring (May-June) and autumn (Oct-Nov). The entire region, however, may have small populations totaling less than 350. Some unconfirmed reports of a similar migration in a valley south of Chumur were also obtained. Such reports were also earlier obtained based on interviews with horse traders from Spiti who trade with people from Chumur (Bhatnagar, unpublished data).

In order to survive the very harsh environs of its habitat chiru develops a thick underwool of very fine quality. Nomads from the Tibetan Changthang collect this and trade with the skilled artisans from Kashmir who weave them into highly prized *shahtoosh* shawls and scarves. It has been learnt that most of this wool actually comes from animals hunted down by some nomads from the region which has led to severe reduction in the chiru population in recent years (Schaller 1998). The Jammu and Kashmir Wildlife (Protection) Act 1978 unfortunately includes the chiru under its Schedule II, which allows hunting within our territory on payment of a small license fee. In spite of this, no license has been issued for many years and poaching has not been reported from the chiru range in Ladakh. They are however, under severe threat across the border and even minor disturbance here could reduce populations using the Indian part of the range.

The Changchenmo region is home to a small population of wild yak where Salim and Bashir (undated) saw 47 yaks in the mid 1990's (Fig 5). One informant from Chushul said that wild yak were seen some years ago in the Galwan nala and Kugag in Changchenmo. The presence of these rare species (chiru and dong) in the northeastern part of Ladakh makes this a very important region from the conservation point of view. Both species are reported to be poached across the border in China (Schaller 1998, Fox, J.L. pers. comm.), and there are earlier reports of some poaching on the Indian side as well (Ranjitsinh 1981). However, such incidents have probably declined at present within the Indian territory.

Given the fact that the region used by chiru and wild yak is of strategic importance to the Armed Forces and that the State's Wildlife Department has almost no authority over this remote area, it is important that the former take up the responsibility of monitoring and conserving the species, with the support of scientists. As a beginning, details such as the population size, movement patterns of the migrating populations, and intensity of use by chiru and dong need to be urgently assessed.

8.4.5 Large Carnivores

Five species of large carnivores reported from Ladakh are the snow leopard, wolf, wild dog, red fox and lynx. Of these the primary predators of large wild and domestic prey are snow leopards and wolf. While snow leopards prefer rugged and steeper areas where they can approach and stalk their prey, wolf prefer rolling slopes, or plains where they can run down their prey (Fox *et al.* 1991a, Schaller 1998). Hence, while snow leopards were mainly found in western and central Ladakh, wolf was more common in the eastern parts. In the areas surveyed during this study the primary predator was wolf, although the numbers in all survey blocks were reported to be very rare or rare as per our interviews (Table 3). Snow leopard occurred primarily in the north, between Kharu and Tangtse and in the Parma Valley. Lynx and wild dog are reported from a variety of habitats covering both rugged and rolling slopes and occurred in the entire surveyed region but were extremely rare through out.

There were reports of damage to livestock by snow leopard and wolf from some regions although we did not make any systematic efforts to access the extent of damage to livestock. Some nomads said that lynx sometimes raided livestock corrals and that wild dogs have never damaged livestock so far.

An interesting finding of the study was one possible sighting of the sand fox (*Vulpes ferrilata*) in the Parma valley. This species has not been so far reported within the Indian Territory but is reported further east in Tibet (Schaller 1998). The animal was distinctly light brown/yellow coloured, had a large white tip that covered over half its tail, and was smaller than the red fox.

8.4.6 Livestock Populations

Livestock were ubiquitous along the study routes. The stretch from Loma to Hanle, Chushul to Loma and the Parma Valley had a particularly large presence of livestock that accounted for 81 % of total livestock seen based on our roadside counts (Table 5).

Sheep and goats constituted the bulk of the livestock seen in the region (87 %), followed by yak and cattle (9 %), horses (4 %) and very few donkeys (0.03 %).

Both, the abundance and livestock species composition information based on this study reflect the trends as observed adjacent to the roads. This trend should be representative as nomads reported that during this season most of the animals of the region were herded along roads, but few additional yaks were left in the upper pastures too. Sheep and goats also may be slightly underrepresented in this sample as some groups were briefly taken higher on the slopes in the side valleys during the day.

Table 5: Livestock numbers based on road counts along the survey route. Figures in parenthesis denote number of sightings. (Pl. see Table 4 for distance covered in each section)

Survey Block	Sheep & Goat	Yak & other Cattle	Horse	Donkey	Total	% of Total Livestock seen
Loma-Hanle	3,326	25	59	0	3,410	29.1
Chushul-Loma	2,720	365	37	0	3,122	26.6
Parma Valley	2,500	442	61	0	3,003	25.6
Pongong Tso (S Bank)	1,025	167	222	0	1,414	12.0
Hanle plains	480	75	106	3	664	5.7
Loma-Demchok (Indus)	75	5	29	0	109	1.0
Total	10,126 (54)	1,079 (40)	514 (42)	3 (2)	11,722 (138)	

The eastern Ladakh region is famous for its *pashmina* goats and they dominated the holding. However, it was not possible to count sheep and goats separately in any of the sightings. Their groups were normally in a few hundreds, with a mean size of 188 animals per group ($\pm$ SE 23.6). As per records from the Sheep Husbandry Department of the total 1,26,500 herds of sheeps and goats the latter dominated (57%) the holding over sheep (43 %) in the entire Changthang region (in 1998-99; unpublished data, Sheep Husbandry Dept.). Yaks and cattle mostly occurred in groups of up to 100, with a mean group size of 27 animals per group ($\pm$ SE 5.6). Horses mostly occurred in smaller groups and the mean group size was 12 animals ($\pm$ SE 1.5).

8.4.7 Possible impacts of livestock grazing on wildlife

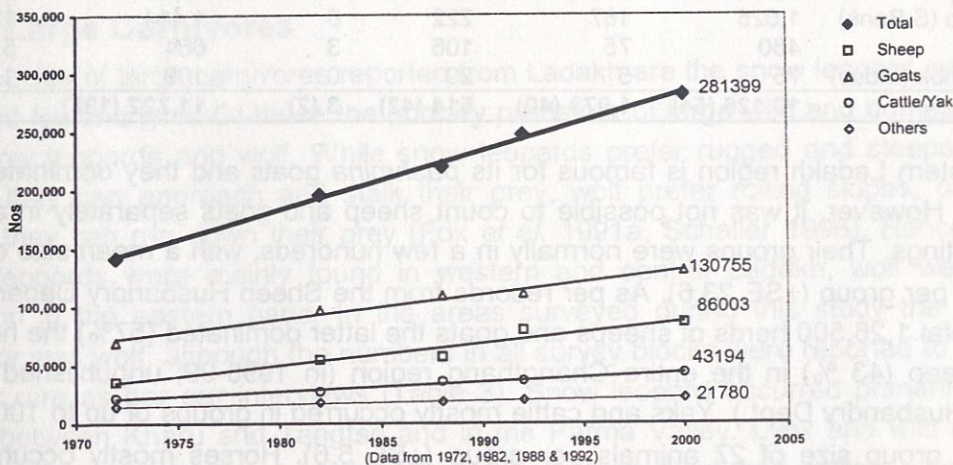
Some high altitude vegetation communities are said to be grazeophil communities, communities that have evolved as a result of grazing by wild and domestic herbivores and tolerate grazing (Rawat and Rodgers 1988). Some studies show that moderate stocking levels do encourage diversity and productivity of rangelands in the Himalaya (Rawat & Rodgers, 1988). Conclusive information on such issues is however, absent in literature for the Himalayan region and is needed for each physiognomic unit or vegetation community within the Trans-Himalaya for designing any reasonable management intervention. People inhabiting the eastern part of Ladakh are entirely pastoral, save a very small proportion of the families that may partly rely on cultivation. Herders have been grazing their livestock in almost every area that offers even little forage. As per the District Livestock Census Reports, the livestock population in the Leh (including Changthang) and Kargil districts have increased by about 1.8 times or a 75% increase in two decades, between 1972 and 1992 (Anon. 1998b; Fig 6). This

increase is most evident for sheep (2.2 times) followed by cattle (1.7 times), goats (1.6 times) and other livestock (1.4 times). All patterns of growth fitted a linear growth trend during the specified period as details given below:

Total Livestock	$y = 0.0118X + 5.1496, r^2 = 0.9646$
Sheep	$y = 0.0153X + 4.5491, r^2 = 0.8654$
Goats	$y = 0.0106X + 4.8472, r^2 = 0.9411$
Cattle/Yak	$y = 0.0124X + 4.3204, r^2 = 0.9918$
Others	$y = 0.007X + 4.1554, r^2 = 0.9456$

(Where 'y' is the log transformed population in a given year, 'x' is the number of years from 1972, and the factor multiplied by x in the equation is the slope or the annual observed rate of increase during the 20 years (Caughley 1980))

Fig 6: Growth in Livestock population between 1972 and 1992 in the Leh & Kargil districts of Ladakh (source Anon. 1998). Extrapolated values of the population at their respective growth rates for the year 2000 and 2010 are also given (pl. see text for more details)



Based on the slope of the curves, the present (2000) total livestock population is likely to be 2,81,399 and given every trend being same in the next 10 years, the population would increase to 3,32,395. Such extrapolations for other livestock types are also provided in Fig 6.

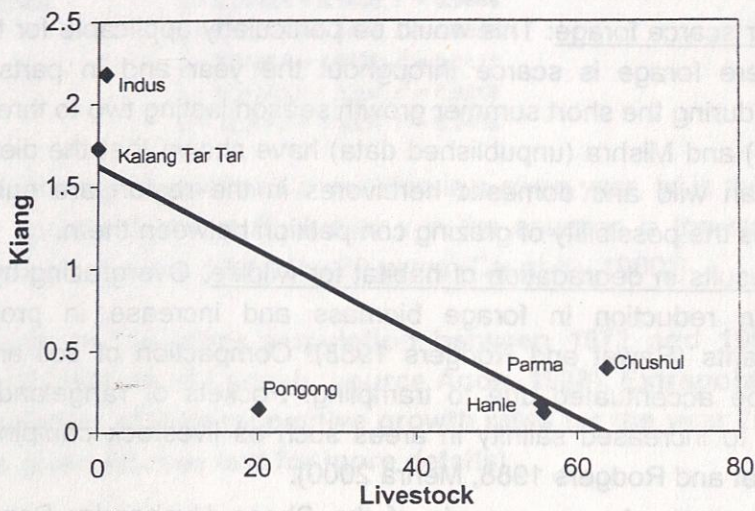
The Sheep Husbandry Department of the state are making efforts of increasing wool production by increasing sheep and goat holdings, especially in the nomadic regions of eastern Ladakh that produce good quality *pashmina* wool (Richard 1999). There also appears to be a variety of regional differences in trends of livestock population growth and composition and their impacts on the ecosystem (see Saberwal 1996 and Mishra and Rawat 1998). Most of such changes and social transformations are being caused as a result of outside forces such as demand for wool, meat, availability of grains and other resources from the Indian mainland and the influence of tourism (Norberg-Hodge 1981, Fox *et al.* 1994). For example, within Ladakh, the relatively higher rates of growth for sheep and cattle presented in Fig 6 may largely be due to higher demand for sheep wool, meat and cattle milk primarily from regions in central and western Ladakh, outside Changthang, where the growth rates for goat may be higher.

The increased livestock in the region could have a variety of impacts on the ecosystem. While we do not have conclusive data to prove overgrazing by livestock in the region at this stage, possible impacts of overgrazing by livestock can be summarized as:

1. Competition for scarce forage: This would be particularly applicable for the Trans-Himalaya, where forage is scarce throughout the year and in parts, may be abundant only during the short summer growth season lasting two to three months. Schaller (1998) and Mishra (unpublished data) have shown that the diets of most Trans-Himalayan wild and domestic herbivores in the region are quite similar, which increases the possibility of grazing competition between them.
2. Overgrazing results in degradation of habitat for wildlife. Overgrazing by livestock could result in reduction in forage biomass and increase in proportion of unpalatable plants (Rawat and Rodgers 1988). Compaction of soil and erosion losses could be accentuated due to trampling. Pockets of rangelands may be degraded due to increased salinity in areas such as livestock camping sites on pastures (Rawat and Rodgers 1988, Mehra 2000).
3. Transfer of diseases. As per records of the Sheep Husbandry Dept., a large proportion of sheep and goats in Ladakh are infected with contagious diseases such as Foot and Mouth Disease and lung infections. The numbers of animals getting treated in various centres for such diseases has been fluctuating between 7,665 and 44,847 in different years in the past two decades (Anon. 1998b). The highest number of cases (44,847) reported for treatment was during 1991-92. The actual number of disease cases is likely to be higher in any given year than those that were treated. Recent epidemics of FMD in UK and some other European countries should be used as a reminder for the devastation that such diseases may cause in this largely pastoral region.
4. Breeding performance of wildlife and domestic livestock. There is recent evidence that overstocking of livestock has a negative feedback on its own productivity and that of other wild herbivores (Mishra, unpublished data). If conclusively proved, this can have serious implications on moves to increase livestock numbers indefinitely for wool production, as the interests of the wool industry as well as wildlife conservation would suffer due to decreased productivity of livestock and wild herbivores.

Our preliminary findings do suggest that presence of livestock is a deterrent to kiang using the same areas. Comparative data for kiang and livestock encounter rates suggests that kiang seem to avoid livestock as areas that had heavy livestock presence had fewer kiang (Fig 7). The trend, however not strong, is indicative of avoidance of areas with higher livestock by even a generalist feeder such as kiang. For a specialist feeder such as the Tibetan gazelle, the impacts of excessive livestock grazing to its habitat could be even more drastic. A more detailed discussion regarding possible competition between livestock and gazelle is given in the Section on the Tibetan gazelle above. With the State Government's policy of increased *pashmina* wool production from the region (Richard 1999), it is particularly important to delineate areas exclusively for wildlife so that species such as the Tibetan gazelle and argali may survive.

Fig 7: Kiang encounter rates (nos./km) compared with livestock encounter rates in eastern Ladakh. For more details on the survey blocks, pl. refer to Table 2, 4 and 5.



With the apparent lack of hunting in the region, but with ample suitable habitat, our preliminary analysis suggests that overgrazing by livestock is a major cause for the rarity of most wild ungulates in the region.

Nubra Survey

8.4.8 Bactrian camel (feral and domestic)

Wild Bactrian camels are adapted to cold, arid plains and hills with few water sources and are distributed from the Mongolian Gobi desert, southwest till the Taklamakan desert including populations in Inner Mongolia, Xinjiang and Gansu province of China. Most populations were decimated and fragmented in the early twentieth century under excessive hunting pressures (Schaller 1998). Bactrian camels were domesticated by Mongols and extensively used in trade due to their hardiness and ability to carry loads equivalent to three yaks.

The Nubra region is unique in the presence of a population of domestic Bactrian camels, most of which are now feral and roam freely in the *Hyppophae-Myrecaria* 'forests' and sand dunes stretching to some 30-40 km along the Shyok river from Khabar to Diskit. The owners apparently have little use of the camels, although some of them are now being used in tourism and for wool production.

History of ownership

The Nubra region was *enroute* on the Leh-Yarkhand branch of the Silk Route trade for many centuries (Rizvi, 1999). The trade continued after independence in 1947 but was discontinued after the Chinese aggression of 1962. Based on our interviews we found that the oldest owners of the camels were two families – the Kalons from Tirit and the Haji Abdul Razzaq family from Sumur. We were informed that usually some of the old or injured camels were left behind by the Yarkhandi traders in Nubra and these two families took care of them. The Kalons said that they had a *serai* or rest house for the

traders and that in 1962 a Yarkhandi stayed back with them to take care of the camels they had. It is from this initial population of approximately 20 animals that the present population of Bactrian camels has grown. As per records at the Yak Breeding Centre there are 6 families at present who own these camels but as per some villagers it is 13 families that own c. 110 camels (Appendix 3a). During our survey we spotted four camels in three groups.

Utility of Camels to Resident People

The Bactrian camels are of little use to the local people at present and are, in fact, considered a threat to crops during summer. It however has potential utility in the tourism and handicraft sectors, and is often used by the Government and tourism agencies as a symbol of the past Silk Route trade during functions and as a unique animal from Ladakh.

The Bactrian camels grow a thick underwool during winters. The light fawn coloured soft underwool from the young animals up to an age of 2-3 years can be used for making elegant shawls. This wool is said to be as effective as the famous *pashmina* or cashmere wool. One young animal may yield about 1-2 kg of underwool, which could produce about two shawls. The coarser wool can be used to make gunnysacks and floor mats. A very few families are doing limited harvest of wool at present, although camel shawls and other wool products may have high market potential. The underwool is sheared in May and the coarse wool is cut afterwards.

Camels are not being used as a beast of burden by local people at present and only one male animal is being used in tourism to conduct 'camel safaris' across sand dunes near Hunder. There are reports that some other people and agencies plan to organize safaris covering larger distances in coming years for tourists. The District officials use camels in the Ladakh Festival processions and for display to various visiting dignitaries. One owner reported to have earned c. Rs. 28,000 in one such function for his five camels. The person who conducts the camel safari at present earns c. Rs. 5,000/- during a season (July-Sept). Hence here again, there is a potential for utilizing the camels.

Possible impacts

Even though the camels are unique to the region, feral populations have potential of damaging the ecosystem. We saw numerous browsing signs on the *Myricaria* bushes and numerous denuded patches with heaps of camel dung that are used by camels as resting sites. Large, free ranging populations of camels may adversely impact the small but dense stands in the valley bottoms.

Adult males are said to be very aggressive during the winter rutting season and have been known to attack humans without provocation. This, along with existing crop damage can lead to conflicts in the region.

Given the symbolic importance and potential values, it is best that proper husbandry measures are taken for rearing camels. It is important for the Government to develop a policy towards their husbandry and population management with the support of the local people.

Further insights on the ecology and behaviour of the camels were available from the local owners and literature and are summarized in Appendix 3b.

8.4.9 Ladakh Urial

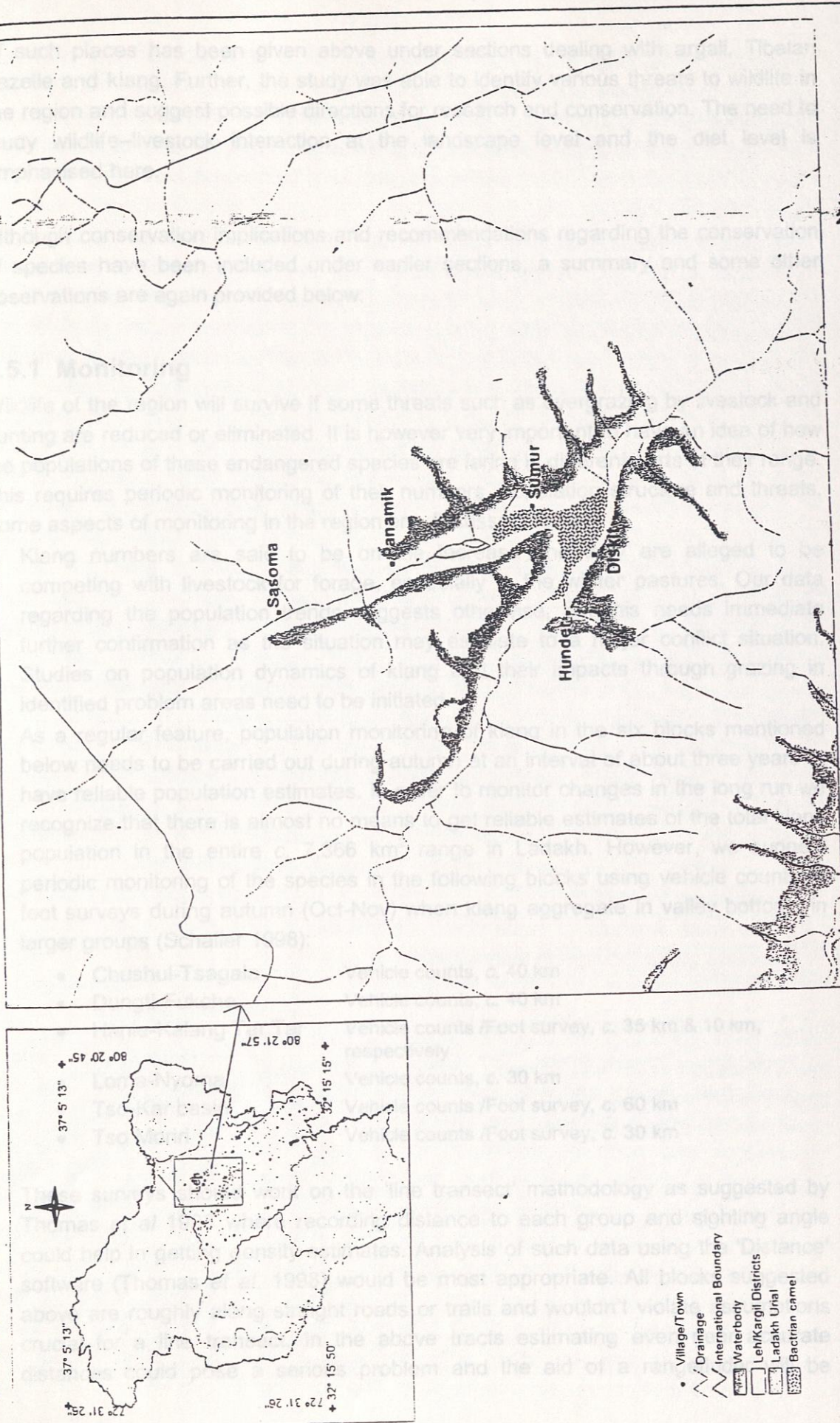
The Nubra region has a population of the endemic Ladakh urial that occurs along the lower slopes of the Shyok and Nubra rivers. Based on evidence and interviews, the population is distributed from near the Shyok village in the east to Diskit in the west, and from the confluence of the Nubra and Shyok River up till almost Panamik, in the north (Fig 8). Within this range, there seem to be more urial on the slopes adjoining Tirit and Sumur. Chundawat and Qureshi (1999) reported c. 1,300 to 1,400 urial in an estimated 2,724 km² range in Ladakh. Of this, we estimate not more than 200 urial in the entire Nubra region. Like elsewhere in its range, within Nubra, the urial range overlaps with the area of maximum human activity – the area with villages, plantations and cultivation. The easy accessibility of the urial range also had resulted in overhunting in the past (Mallon 1991, Fox *et al.* 1991a). In the Nubra region there is excessive movement of vehicles and the human population density is also very high. Thus the future of this population, that actually occurs within the Karakorum Wildlife Sanctuary may be very insecure.

The Nubra population of the Ladakh urial seems of be isolated from the population along the Indus River by the Ladakh range, where the lowest route would be through the Khardungla (5,234 m), that is way above the known altitudinal range used by urial. The Shyok River meets the Indus in the Gilgit region of the PoK. Downstream along the Shyok the area becomes extremely rugged and in the entire 90km stretch surveyed beyond Diskit we did not obtain any reports of the occurrence of the urial, however, ibex was reported from this region (mainly using the upper slopes). It is thus not clear which route the colonizing population would have taken.

8.5 Conclusions and Recommendations

The present study was the first in the region after the early explorations during the British period (Burrard 1925, Stockley 1936, Ganher 1979) and some surveys about two to three decades ago (Ranjitsinh 1981, Dar 1984). Further, more these previous studies were largely anecdotal in nature. One important consideration in the present survey was to cover maximum ground to collect basic information on large mammals, thus the summer season was chosen due to better logistics. Owing to the rapid nature of the survey, and its being in a season not very appropriate for wildlife viewing, but with good mobility, it had some inherent limitations relating to obtaining observations. The study, however, establishes the baseline for regions where further surveys need to be carried out during winter or spring to assess the accurate status of wildlife. A list

Distribution of Ladakh Urial in the Nubra region of Ladakh. Inset shows the distribution map of the urial in Ladakh based on Chundawat and Qureshi 1999.



...their importance and potential value. It is best that proper husbandry practices are taken for it and that it is a priority for the Government to develop a policy towards their husbandry and population management with the support of the Government.

...of the species and the status of the current wild population. The authors and narrative are summarized in Appendix 3b.

8.4.2 Ladakh, India

The region has a population of the endemic Ladakh ibex that lives along the upper reaches of the Shyok and Indus rivers. Based on evidence and information, the population is considered to be near the Shyok village in the east to Diskit in the west and from the confluence of the Indus and Shyok River up to the area of the Ladakh range. There should be more ibex on the slopes of the Ladakh range. (Günther 1979) reported c. 1,000 to 1,500 ibex in the Ladakh range. We estimate that there are about 1,000 ibex in the Ladakh range, which is close to the area of the Ladakh range. The area with ibex is not very large. The area of the Ladakh range is not very large. According to the data of Günther et al. 1991, the population of ibex is not very large. The area of the Ladakh range is not very large. The area of the Ladakh range is not very large.

The population of the Ladakh ibex seems to be isolated from the Indus River by the Ladakh range, where the lowest point is about 5,234 m, that is way above the known altitude range of the Shyok River meets the Indus in the Gilgit region of the Pak. Beyond Diskit the area becomes extremely rugged and in the area of the Ladakh range beyond Diskit we did not obtain any reports of the ibex. The lowest ibex was reported from this region (mainly using the upper part of the Ladakh range which is the main range of the population would have been).

8.5 Conclusions and Recommendations

The present study was the first in the region after the end of the British period (Burrard 1926, Stockley 1936, Günther 1979) and some two to three decades ago (Ranjitsinh 1981, Dar 1984). Further, the study was largely anecdotal in nature. One important conclusion is that the present study was chosen due to better logistics. Owing to the study being in a season not very appropriate for wildlife study, it had some inherent limitations relating to obtaining data. However, it establishes the baseline for regions where further study is needed, either during winter or spring to assess the accurate status of the population.

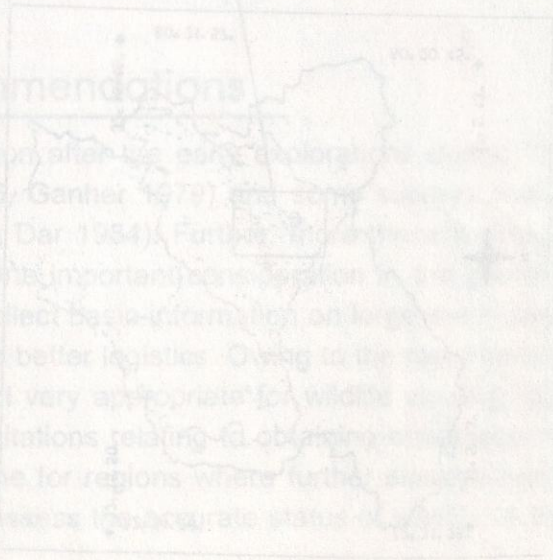


Figure 8.5: Distribution of Ladakh ibex in the region of Ladakh, India. The map shows the distribution of ibex in the region of Ladakh, India, with a scale bar and a north arrow.

of such places has been given above under sections dealing with argali, Tibetan gazelle and kiang. Further, the study was able to identify various threats to wildlife in the region and suggest possible directions for research and conservation. The need to study wildlife–livestock interaction at the landscape level and the diet level is emphasised here.

Although conservation implications and recommendations regarding the conservation of species have been included under earlier sections, a summary and some other observations are again provided below:

8.5.1 Monitoring

Wildlife of the region will survive if some threats such as overgrazing by livestock and hunting are reduced or eliminated. It is however very important to have an idea of how the populations of these endangered species are faring in different parts of their range. This requires periodic monitoring of their numbers, population structure and threats. Some aspects of monitoring in the region are discussed below:

1. Kiang numbers are said to be on the increase and they are alleged to be competing with livestock for forage, especially in the winter pastures. Our data regarding the population trends suggests otherwise, but this needs immediate further confirmation as the situation may escalate to a major conflict situation. Studies on population dynamics of kiang and their impacts through grazing in identified problem areas need to be initiated.
2. As a regular feature, population monitoring of kiang in the six blocks mentioned below needs to be carried out during autumn at an interval of about three years to have reliable population estimates. In order to monitor changes in the long run we recognize that there is almost no means to get reliable estimates of the total kiang population in the entire c. 7,366 km² range in Ladakh. However, we suggest periodic monitoring of the species in the following blocks using vehicle counts or foot surveys during autumn (Oct–Nov) when kiang aggregate in valley bottoms in larger groups (Schaller 1998):

- | | |
|------------------------|---|
| • Chushul-Tsagala | Vehicle counts, c. 40 km |
| • Dungti-Fukche | Vehicle counts, c. 40 km |
| • Hanle-Kalang Tar Tar | Vehicle counts /Foot survey, c. 35 km & 10 km, respectively |
| • Loma-Nyoma | Vehicle counts, c. 30 km |
| • Tso-Kar basin | Vehicle counts /Foot survey, c. 60 km |
| • Tso Moriri | Vehicle counts /Foot survey, c. 30 km |

These surveys should work on the 'line transect' methodology as suggested by Thomas *et al* 1998 where recording distance to each group and sighting angle could help in getting density estimates. Analysis of such data using the 'Distance' software (Thomas *et al.* 1998) would be most appropriate. All blocks suggested above are roughly along straight roads or trails and wouldn't violate assumptions crucial for a line transect. In the above tracts estimating even near accurate distances could pose a serious problem and the aid of a rangefinder will be

essential. As sightings are possible as far as 5-6 km it may be beyond the capacity of most rangefinders and here, plotting the locations on the map and estimating distances from there could solve the problem. This would also facilitate development of a spatial database and information on the distribution of the species. For better estimates each transect should be run at least three times in a span of 10-15 days.

We also understand that there could be sub-population movements, thus causing variations in the abundance estimates as also suggested by Fox *et al.* 1991a. Schaller (1998), however, reported that kiang is unlikely to undertake long distance migrations. Recognizing this, but considering that not all populations may be migratory, it is still important to initiate the process of monitoring kiang abundance as this species has a potential to result in serious human-wildlife conflict relating to perceived damage to winter pastures of livestock. It is urgently required to look into whether this problem actually exists on the ground, where the problem areas are, and whether the kiang populations are actually increasing in these areas. Also, we need to look into the local herding practices and livestock holding trends to ascertain whether the problem is due to an increase in kiang numbers or increase in the commercially important *pashmina* goats that is resulting in conflicts.

3. Many areas of prime or potential wildlife habitat as mentioned in respective sections above occur in regions where the Army and the Paramilitary forces have substantial presence. After a brief study in this region Brigadier Moti Dar (1984) had felt that "... the armed forces' possible contribution to conservation remains untapped. Harnessing this vital potential force may be the single most important conservation advance India could make in the battle to save what remains of its natural wealth." We would like to reiterate this and say that for extremely rare species such as argali, Tibetan gazelle, wild yak and Tibetan antelope, the few remaining sites with the species should be monitored by the Army/Paramilitary forces as this may be the only reliable source of continued information on these species from the region.
4. The Wildlife Institute of India could periodically train the interested personnel regarding these monitoring techniques.

8.5.2 Other Conservation action

1. Participating management: The Tibetan gazelle is in an extremely precarious position in Ladakh and extinction seems imminent in the near future. The only small populations that exist seem to be under threat from grazing competition from livestock and poaching and need to be immediately conserved by adopting innovative means. Using various participatory approaches is the only answer where the local communities are allowed a stake in the process, while having to give away the rights of grazing their livestock in selected parts. Experiments like this from similar sites in the Trans-Himalaya have shown promising results where scientists have leased out pastures from the herders for grazing related studies based on agreements (Anon. 2000; Mishra, C., personal communication). Further, such activities may be linked with additional income generation through the development of ecotourism activities too. The potential for ecotourism in the Haule

region and in most of Ladakh is immense and linkages with participatory management of PAs would benefit conservation efforts in the region.

2. Feral dogs around Army/ITBP camps and villages: At all camps we saw numerous feral dogs that were seen chasing livestock. Dogs in many areas were reported to be an important predator of livestock and would be of threat to the wildlife too. Most of the feral dogs formed packs and were seen engaged in a livestock chase on two occasions. We saw 48 dogs in one big group near the ITBP camp in Hanle and the soldiers said that sometimes even they felt threatened from the dogs at night. This was at a site very close to where black necked cranes normally nest. Similarly, dogs were quite common in the lower areas in Nubra too where the small population of the Ladakh urial may be affected by their harassment. In similar areas in Spiti, dogs have been seen chasing and attacking ibex (Bhatnagar 1997). Agencies such as the Defense forces could help by culling feral dogs. If resources permit, castration of male dogs needs to be carried out to reduce their numbers.
3. Conservation education: During our survey a common question asked by many persons from the Army and other Government agencies was "What wildlife? Do we have any animals here?" Some persons were only aware about the marmots and wild ass. This thus shows that the level of awareness of their environment is rather poor. We need to design popular means by which this entire group of people is made aware about the rich diversity of large mammals and other fauna and flora of the region. Also, it needs to be stressed that they could play an important part in the conservation of many of these species that are likely to go extinct in the near future.
4. Training: Much of the useful information on the population status, composition and threats of wild animals can be obtained by the Army/ITBP forces as well as the local nomads. Most of them however would need training regarding the techniques that should be made available to them. Such training for wildlife monitoring is again mentioned in this section to highlight the role of monitoring as a conservation tool (see also point 3 & 4 above in the 'Monitoring' section. The region also is reported to be on the illegal trade route of wildlife and wildlife products (Wright and Kumar 1997). The identification of derivatives especially can be very difficult and the security forces may need training by organizations such as WII and some NGOs regarding correct identification of products and the provisions of the Indian and the J & K Wildlife (Protection) Acts.
5. Anti-poaching activities: Poaching was felt to be rare in the region surveyed except for its possibility in the Hanle Tibetan gazelle populations. These populations are already very precarious and the ITBP and ITBF posts there, which have a good intelligence network, should take special interest in identifying and apprehending any culprits involved in poaching.
6. Rationalization of PA boundaries. Most of Ladakh can safely be called a 'wilderness area' and 8,990 km² (9.29%) is already under PA coverage and more, covering an area of 20,190 km² (21 %) has been proposed (Chundawat and Qureshi 1999). Apart from these, there are some very large PAs such as the Karakorum WLS (c. 6,000 km²), whose boundaries are not defined and which include numerous human habitations and army installations. Many of the PAs are large, but major proportions of their land are usually under glaciers or are rocky and of little direct value to wildlife.

A common lament of various developmental organizations is that since large areas are under the Wildlife Department they unduly curtail their activities. Such a situation makes the position of the Dept. difficult in the eyes of the local communities and the other departments. Large PAs are required in the Trans-Himalayan regions as many species such as snow leopard do require large areas for the maintenance of a viable population (Chundawat 1992, McCarthy, Tom, pers. comm. 2000) and many herbivore species usually undertake seasonal migrations that may be separated by great distances (Schaller 1998). Any PA should cover all such areas. The Trans-Himalayan region of Ladakh also has many peculiarities posed by scarcity of resources and the consequent limitations on rehabilitating people affected by the presence of a PA. It is thus important that the boundaries of the PAs are carefully delineated based on biological values determined through targetted survey and that in larger areas the local communities are meaningfully involved in conservation efforts. Chundawat and Qureshi 1999 have delineated priority areas based on the occurrence of large mammals and is an important step towards coming up with PAs that could conserve wildlife. What is further needed is to find out the best places for wildlife conservation. Carefully located 'satellite core zones' in large PAs, outside which human activities may be allowed, may be a suitable alternative.

7. In Nubra there is potential for using the Bactrian camels for various tourism and handicrafts related activities (for more on this aspect, see section on utility of camels above), and this potential should be tapped. The authorities also must make efforts to develop suitable husbandry practices so that the animals may not stray out and become feral.

Itinerary followed during the survey

Date	Night Camp	Place (s)	Distance covered (km)
Eastern Ladakh Survey			
July 21	Kharu	Leh – Kharu	32
22	Tangtse	Kharu – Tangtse	81
		Parma Valley	30*
23	Tangtse	Tangtse – Merak	70*
24	Chushul	Tangtse – Chushul	74
25	Chushul	Chushul – Merak	30*
26	Fukche	Chushul – Fukche	123
27	Fukche	Fukche – Demchok	40*
28	Loma	Fukche – Loma	63
29	Hanle	Loma – Hanle	61
30	Hanle	Hanle villages	20
31	Hanle	Kalang Tar Tar Valley	35*
Aug 1	Loma	Hanle – Loma	153
2	-	Loma-Leh	215
Nubra Survey			
Aug 12	Khalsar	Leh – Khalsar	91
13	Partapur	Khalsar – Partapur	47
13	Partapur	Diskit forests & Yak Breeding Centre	20*
14	Partapur	Diskit forests	25*
15	Khalsar	Partapur – Panamik	79*
16	Khalsar	Khalsar – Turtuk	125*
17	-	Turtuk-Leh	91

* Distance for return to night camp not included

Notes on Group Size and Habitat Utilization by kiang

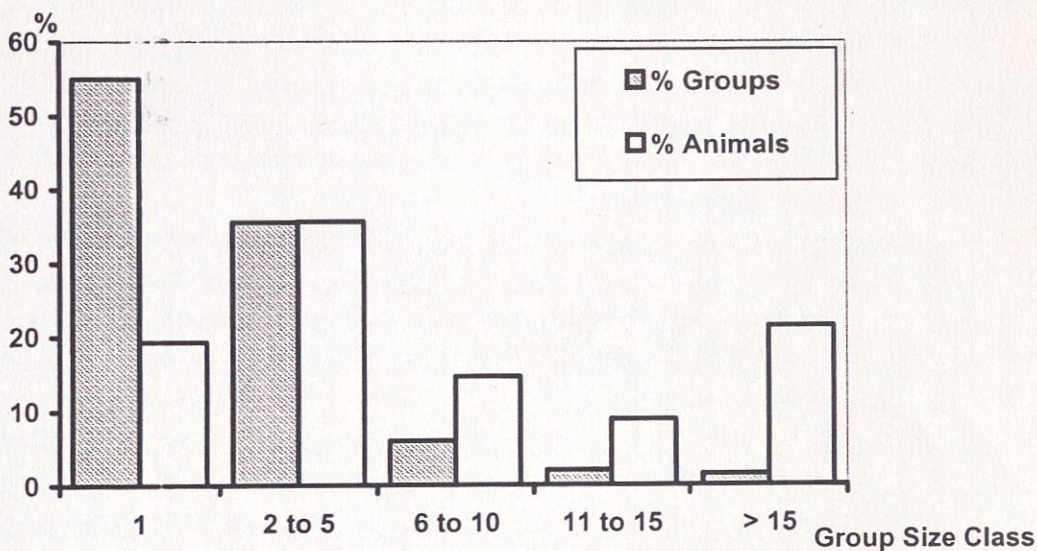
Kiang group size

All the 202 sightings, where 574 kiang were seen have been considered in the analysis for group size and habitat usage presented in this section.

Kiang have fluid groups that often change in size and composition. The only stable unit is a female with its foal or yearling. Aggregations may occur when over 500 kiang have been recorded in the Arjin Shan reserve in Tibet (Shah and Huibin 2000). It is difficult to classify the two sexes from a distance as they are quite similar (Groves 1974, Schaller 1998) and due to this limitation, we are only discussing the group sizes and not the composition of the population. Groups were identified as a set of individuals who were closer than 30m, had similar activities and direction of movement.

We observed groups ranging from solitary animals to a group of 74 kiang during the survey. The mean group size was 2.84 (SE 0.42) and the median group size was 1. Bulk of the sightings (55 %) were of solitary animals, and a very small proportion of the sightings (1.5 %) occurred in groups of over 10 animals (n=202, Fig A). In all, 91 % groups sighted were small (1-5 animals). Looking at the proportion of individuals that were present in different group size categories, bulk of them (55 %) again were in small groups of up to 5 animals followed by 21 % in the >15 animals category (n=574, Fig A).

Fig A: Group sizes of kiang in eastern Ladakh during July 2000. Percent Groups shows the proportion of groups in a certain group class (n=202) and the % Animals shows the proportion of kiang individuals in each group class (n=574).



Schaller (1998), based on his study in Tibet has also reported the preponderance of smaller groups and solitary animals during July-August, which is also the rutting and foaling period of kiang. The proportion of solitary animals in his study was 13.6 % of the number of kiang counted compared with 19.63 % during the present study. He also

reported that the proportion of solitary animals dropped after September, when the effect of rutting and parturition waned off. Schaller (1998) suggests that the preponderance of solitary animals and smaller group sizes during summer may be due to the 'disruptive time of mating and giving birth'. Kiang stallions tend to herd harems, but before that may have to roam about extensively in order to find potential mates and compete with other males. There is also a possibility that some males may try to maintain temporary territories and herd any passing mares into their harem. Most of such animals thus would roam around alone or occur in small groups.

Food availability also may have a role to play in the occurrence of small group sizes during summer. This aspect has however not been investigated for kiang so far. Only during summer the availability of forage, both in terms of quantity and distribution of resources is high in the Trans-Himalayan habitat of kiang. We feel that this fact enables the kiang females in late pregnancy or those with young foals and also stallions in search of potential mates to occur in smaller groups and utilize almost any part of the habitat that provides lesser disturbance. In other seasons, when suitable habitat may get restricted due to snowfall, colder temperatures and enhanced threat from predators, kiang would occur in larger groups in whatever suitable habitat is available. Schaller (1998) and Shah and Huibin (2000) in Tibet, and Shah (1994) in Sikkim observed such larger groups and aggregations of over 500 kiang from autumn to spring. We suggest that larger group sizes during this period could also be an anti-predatory strategy (see also Hamilton 1971, Jarman 1974) at a time when the primary predator of the region, wolf, may have greater dependence on kiang. There have been reports of wolf predation on wounded adult kiang and weak foals (Shah 1997, Shah and Huibin 2000). Nomads from the region said that their livestock losses to wolf predation suddenly increased in autumn after the marmots went into hibernation, an argument that may be extended to increased dependence of wolf on other wild prey such as kiang young and argali during these months. Even though this fact needs validation, but if true, it lends credence to the possibility of larger group sizes of kiang during this period as an antipredatory strategy.

Notes on habitat use by kiang

Most kiangs were seen in open wide valleys (79 %, n=202), followed by slopes with few boulders and stones (19 %) and where very rarely seen in the more broken ones (2 %). Kiangs were mostly seen on flat areas (79 %) or gradually sloping ones (21 %). No kiangs were seen on slopes with an inclination of over 30°. We observed kiang between an elevation of 4,100 and 5,300m. Bulk of these sightings (65 %) were between 4,200 and 4,300m. Most kiang groups (82 %) were seen on valley bottoms that were dominated by sedge-grass meadows, sometimes interspersed with bushes of *Caragana* sp. The remaining sightings were in areas that had sparse to dense *Artemisia* sp., *Tenacitum* sp. or *Sedum* sp. Kiang were seen in areas devoid of vegetation to those that had a continuous mat of vegetation. The sightings were however biased towards sites with a high plant cover of over 70 % coverage (85 %), which were mostly grass-sedge communities. Over 64% of the kiangs were seen between Dungti and Fukche (Loma-Demchok block), a distance of c. 50 km, that was in the valley bottom and dominated by sedge-grass meadows, interspersed with *Caragana* bushes.

Appendix 3a

Owners of Bactrian camels and their holdings as per various informants

(even though the general acceptance was that there are 110 camels, only 60 to 100 animals could be attributed to owners, further showing the lack of clear ownership of the camels)

Village	Name of Owner/Family	Approx. Holding
As per Dr. Mhod. Baqur, Incharge, Yak Breeding Center, Diskit		
Skampuk	Rinchen	4
Hunder	Razzaq	10
	Quadir	4
Diskit	Sadupa	40
Sumur, Tirit & Tegar	Kalons & Haji Abdul Razzaq (Conflict in ownership)	40-45
As per Mr. Haji Abdul Razzaq, Hunder		
Skampuk	Rinchen	2
Hunder	Abdul Razzaq	4
	Haji Mhod. Hussain	4-5
	Gulam Qadir	2
	Gulam Mehdi	1
Diskit	Mhod. Musa	6-7
	Rozi Mhod.	20-25
	Ibrahim	1
	Mhod. Abdullah	2-3
Tirit	Wangdus Kalon (Kalon household)	3
Sumur	Haji Abdul Razzaq	30
	Skalzang (Saptopa household)	4
	Sonam (Zimskam-yogma household)	3-4

Notes on Ecology and Behaviour of Bactrian camels

Schaller (1998) has described the morphology of wild and domestic Bactrian camels. The Yak Breeding Centre at Diskit also has maintained interesting records about their biology. Dr M. Baqur from this Centre informed that the males are ready to mate between December and March, however, mating peaks in January-February. During the rutting peak the adult males are very aggressive and often froth in the mouth. Young are born after a 14-month gestation in March-April. Females may conceive every alternate year. He reported that adult males weigh c. 600 kg and females c. 500 kg. The weight on birth was 26-29 kg. Animals in captivity may survive till they are 30-35 years old.

Mr. Mohammed Shafi from Hunder is involved with the camel safaris and was well versed with their behaviour. He agreed with the above information, but felt that the free ranging camels rarely survived beyond 20-25 years. He also provided interesting insights into their rutting behaviour. In aggressive encounters with other males, contestants bare their teeth, exposing their 1.5-inch long 'canines' and often froth in the mouth. A confrontation usually begins with shoulder pushing and entwining of the legs. Males often try to bite off the tail and penis of the contestant. If one male falls down, the other one tries to mount on his neck and crush it under his weight, sometimes leading to the death of the animal. An aggressive visual and olfactory signal to another male includes a repertoire when one male spreads its hind legs, urinates on its tail and splashes it on its hind hump. The victor of the contest usually chases the vanquished male a long distance before returning to the females. Here, he herds all the females and strongly maintains his harem. He often needs to chase females over great distances in the process of herding them together. Most aggressive encounters occur in males older than five years and younger males keep a safe distance of a few hundred meters from such contests.

Camels mostly use areas along the confluence of the Nubra and Shyok Rivers, which forms a vast plain at an elevation of 3,100 to 3,200m. This region has:

- ◆ patches of grass sedge meadows,
- ◆ riverbanks that may be sandy or at times rocky,
- ◆ sand dunes, and
- ◆ dense *Hippophae-Myricaria-Lycium* stands.

The dense stands with some open sandy patches in between are clearly preferred by camels during most seasons as per our informants. During summer they spend considerable time near the riverbanks that are cooler. They also wallow in mud, probably to escape from excessive harassment by flies.

Camels are mostly sedentary during most seasons, however, they move large distances during winter. This may be in response to the long chases during rutting and the sparsely distributed forage.

Mortality seems to be due to a variety of reasons. Young may die in seasonal floods in the Shyok River, and to wolf predation. Herders in Nubra said that some owners monitored the birth of young and brought the young one with its mother to their house for about a month to protect it from wolf depredation. Adults may suffer from a variety of diseases including some kind of blindness. Another disease affects their limbs and animals are unable to stand. The affected animals perish while beating about their limbs, often forming a crater on sand. They are also afflicted with a lung disease.

Based on interviews it was found that on an average the population produces about 15 young every year, but only 4-5 survive the frequent floods in the Shyok river during summer and predation by wolves. The population is however increasing gradually, and has increased to 110 from an initial 20 in the early 1960s (Dr Mohammed Baqur, Yak Breeding Centre, Diskit, pers. commun.).

References

- Anon. 1992.** Indian Wildlife (Protection) Act 1972. Natraj Publishers, Dehradun
- Anon. 1998a.** CAMP Summaries 1995-1998. Conservation Assessment and Management Plan (CAMP) Workshops. Zoo Outreach Organization CBSG, India.
- Anon. 1998b.** Statistical Handbook, Govt. of Jammu & Kashmir, District Leh 1996-97. Directorate of Economics and Statistics. Planning and Development Department. District Statistical Evaluation Agency. (LAHDC), Leh.
- Anon. 2000.** Nature Conservation Foundation, Annual Report for 1999-2000. Nature Conservation Foundation, Mysore, India
- Bhatnagar, Y.V. 1997.** Ranging and Habitat Use by Himalayan Ibex (*Capra ibex sibirica*) in Pin Valley National Park. Ph.D. dissertation, Saurashtra University, Rajkot.
- Burrard, G. 1925.** Big Game Hunting in the Himalayas and Tibet. Herbert Jenkins, London.
- Caughley, G. 1980.** Analysis of vertebrate populations. John Wiley and Sons, Chichester. pp234.
- Chundawat, R.S. 1992.** Ecological studies on the snow leopard and its prey species in Hemis NP, Ladakh. Ph.D. Thesis submitted to the University of Rajasthan, Jaipur. 166p.
- Chundawat, R.S. and Qureshi, Q. 1999** Planning wildlife conservation in Leh and Kargil districts of Ladakh, Jammu and Kashmir. Draft Report submitted to the Wildlife Institute of India, Dehradun. 92 p.
- Dar, M. 1984.** Ladakh. *Sanctuary*. IV(2) 112-129.
- Fox, J.L. 1997.** Rangeland management and wildlife conservation in the HKH. In: Miller, D.J. and Craig, S.R. (Eds.) Rangelands and Pastoral Development in the Hindukush-Himalayas. Proceedings of the regional experts meeting (Nov5-7, 1996. Kathmandu, Nepal. ICIMOD, Kathmandu. Pp. 53-57
- Fox, J.L., Nurbu, C., Bhatt, S., and Chandola, A. 1994.** Wildlife conservation and landuse changes in the Trans-Himalayan regions of Ladakh, India. *Mountain Research and Development*. 14: 39-60.

- Fox, J.L., Nurbu, C., and Chundawat, R.S. 1991a.** The mountain ungulates of Ladakh, India. *Biological Conservation*. 58: 167-190.
- Fox, J.L., Nurbu, C., and Chundawat, R.S. 1991b.** Tibetan argali (*Ovis ammon hodgsoni*) establish a new population. *Mammalia* ----- 48-51.
- Ganhar, J. 1979.** The Wildlife of Ladakh. Haramukh Publications, Srinagar.
- Hamilton, W.D. 1971.** Geometry of the selfish herd. *Journal of Theoretical Biology*. 31: 295-311.
- Harris and Miller 1995.** Overlap of summer habitats and diets of Tibetan plateau ungulates. *Mammalia*. 59(2): 197-212.
- Jarman, P.J. 1974.** The social organization of antelope in relation to their ecology. *Behaviour*. 48:215-267.
- Lydekker, R. 1907.** The Game Animals of India, Burma, Malaya and Tibet. Rowland Ward, London.
- Mallon, D. 1991** Status and conservation of large mammals in Ladakh. *Biological Conservation*. 56: 101-119
- Mehra, B.S. 2000.** Grazing ecology of nomads in Great Himalayan National Park Ph.D. Dissertation submitted to the Saurashtra University, Rajkot.
- Mishra, C. 2000.** Socio-economic transition and wildlife conservation in the Indian Trans-Himalaya. *Journal of the Bombay Natural History Society* 97(1): 25-32
- Mishra, C. & Rawat, G.S. 1998.** Livestock grazing and biodiversity conservation: comments on Saberwal. *Conservation Biology*, 12: 712-714
- Mishra, C. 1997.** Livestock depredation by large carnivores in the Indian Trans-Himalaya: conflict perceptions and conservation prospects. *Environmental Conservation*, 24: 338-343.
- Norberg-Hodge, H. 1981.** Ladakh: Development without destruction. In: Lall, J.S. (Ed.) The Himalaya: Aspects of Change. Oxford University Press, New Delhi. pp. 278-284.
- Rawat, G.S. and Rodgers, W.B. 1988.** Alpine meadows of UP Himalaya: an ecological review. Proceedings of the National Rangeland Symposium, Jahnsi, India, November 9-12, 1987: 119-137. IGFR, Jahnsi, India.
- Ranjitsinh, M.K. 1981.** Himalayan fauna. In: Lall, J.S. (Ed.) The Himalaya: Aspects of Change. Oxford University Press, New Delhi. pp. 64-76.
- Richard, C. 1999.** Rangelands and livestock as a niche opportunity for Ladakh. Sectoral Report in Volume II: Developing Strategies for Agriculture and Related Sectors in Ladakh. Submitted to the Leh Autonomous Hill Development Council by ICIMOD. Jan 1999.
- Rizvi, J. 1999.** Trans-Himalayan Caravens: Merchant Princes and Peasant Traders in Ladakh. Oxford University Press, New Delhi. pp 359.
- Saberwal, V. K. 1996.** Pastoral Politics: gaddi grazing, degradation and biodiversity conservation in Himachal Pradesh, India. *Conservation Biology*. 10:741-749.
- Schaller, G.B. 1998** Wildlife of the Tibetan Steppe. University of Chicago Press, Chicago.
- Shah, N. 1994.** Status survey of southern kiang (*Equus kiang polyodon*) in Sikkim. Dept. of Zoology, Faculty of Science, Maharaja Sayajirao University, Baroda.

- Shah, N. 1996.** Status and distribution of Western kiang (*Equus kiang kiang*) in Changthang Plateau, Ladakh, India. Report M.S. Univ. of Baroda and Gujrat Nature Conservation Society, Baroda, Gujrat.
- Shah, N. 1996.** Status survey of Southern kiang (*Equus kiang polyodon*) in Northern Sikkim. Phase II (Summer 1995), India. Report M.S. Univ. of Baroda and the Zoological Society for the Conservation of Species and Population, MUNCHEN.
- Shah, N. and Huibin, Z. 2000.** Status of kiang (*Equus kiang*) in East Arjin Shan Mountain Nature Reserve, Xinjiang Province, Peoples Republic of China. Report submitted to the China Exploration Research Society, Hong Kong.
- Stockley, G. 1928.** Big Game shooting in the Indian Empire. Constable, London.
- Stockley, G. 1936.** Stalking in the Himalayas and Northern India. Herbert Jenkins, London.
- Thomas, L., Laake, J.L., Derry, J.F., Buckland, S.T., Borchers, D.L., Anderson, D.R., Burnham, K.P., Strindberg, S., Hedley, S.L., Burt, M.L., Marques, F., Pollard, J.H. and Fewster, R.M. 1998.** Distance 3.5. Research Unit for Wildlife Population Assessment, University of St. Andrews, UK.
- Wright, B. and Kumar, A. 1997.** Fashioned for Extinction: An Expose of the Sashtoosh Trade. Wildlife Protection Society of India, New Delhi. pp48.

Acknowledgements

We are deeply indebted to Col. A.K. Singh, Director, Army Ecological and Environmental Cell, Lt. Col. D Banerjee, GSO1 (Engineers), HQ 14 Corps, Commandant, 3rd Battalion, ITBP, Mr. S.K. Mukherjee, Director, Wildlife Institute of India, Dr V.B. Mathur, Scientist SG, WII, for taking keen interest and facilitating the smooth conduct of the survey. We are also very thankful to DQ, 114 Infantry Brigade, DQ 102 Infantry Brigade, Ms. Malik, OC, ITBP, Hanle and all the field officers and soldiers at the posts for their constant support during the survey.

Dr. Rodney Jackson, Dr. V.B. Mathur, Mr. Don O. Hunter, Mr. Charudutt Mishra, Dr. Tom McCarthy, Ms. Perscilla, Ms. Camille Richard and Ms. Nita Shah provided valuable comments on the draft report that has greatly improved its quality.

Hav. Naseem Khan, 102 Engineers, provided efficient liaison during the survey and was also a pleasant company. At WII, many faculty colleagues have provided help during the survey and afterwards, especially Dr. B.S. Adhikari, who accompanied us in the Nubra survey. Mr. Panna Lal and Dr Navneet Gupta of the GIS lab, WII have helped with the analysis and production of the maps. Dr. R.S. Chundawat and Mr Q. Qureshi are also acknowledged for permission to use the base maps of animal distribution prepared by them in 1999 for some of the species covered during this survey. The Chief Wildlife Warden, Jammu & Kashmir is thanked for granting permission to conduct this study. Mr. R. Zargar, Wildlife Warden, Leh & his staff provided support during the study. Mr. Tiwari DFO, Leh went out of the way to help and is duly acknowledged.

Bench Mark Ecological Status of Wetlands of Ladakh

by S.A. Hussain & R.K. Singh

9.1 Introduction

Wetlands are defined as land transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. The wetlands must have one or more of the following three attributes: 1) at least periodically, the land supports predominantly hydrophytes; 2) the substrate is predominantly undrained hydric soil; and 3) the substrate is non soil and is saturated with water or covered by shallow water at some time during the growing season (Cowardin *et al.* 1979). In wetlands the water level is usually less than 2 m. In contrast, the aquatic ecosystems are both lentic and lotic ecosystems usually with standing water more than 2 m in depth. These include lakes and rivers excluding the littoral zones.

The high altitude lakes and wetlands in the Ladakh region of Jammu and Kashmir are restricted to the Changthang region of the Tibetan plateau. These ecosystems are recognized as fragile and are increasingly being threatened due to anthropogenic pressures, particularly due to increased tourism, faulty rangeland management and associated anthropogenic pressures. These ecosystems represent oases of productivity in otherwise arid steppe environment and thus have significant conservation values, particularly as breeding ground for Bar-headed goose *Anser indicus* and globally threatened Black-necked crane *Grus nigricollis* outside China. Other main waterfowl species breeding in the area includes Ruddy shelduck *Tadorna ferruginea*, Common redshank *Tringa tetanus*, Brown-headed gull *Larus brunnicephalus*, Lesser sand plover *Charadrius mongolus* and Great crested grebe *Podiceps cristatus* (Anon, 1993). Because of the unusual and serene landscape of the Changthang region, particularly some of these lakes and wetlands attract a large number of tourists.

One of the characteristic of mountain tourism is high degree of seasonality, which tends to concentrate and enhance its adverse impact on environment (Humbert-Droz's 2000). This is especially true for fragile high altitude ecosystem such as wetlands in Ladakh where tourist access is essentially restricted to summer months, which is also the peak period of biological activity and breeding season for much of the fauna. This may adversely affect the breeding success of the wetland birds, which need frequent monitoring. Given an increased probability of adverse effects on wildlife populations in many places in the Trans-Himalayan region, in the event of any catastrophic disturbance or habitat degradation and modification, the information generated through this study would help in conserving these important ecosystems.

The aquatic ecosystems are classified according to the limnological categories based on the relationship between nutrient contents and productivity. For prioritization of the wetlands it is essential to know the primary characters of wetlands such as the wetland type (saline or freshwater) and the nutrient status (dystrophic, oligotrophic, mesotrophic or eutrophic). Besides, for the organisms in wetlands the physico-chemical environment such as Dissolved Oxygen (DO) and Total Dissolved Solids (TDS) as a whole is as important as the nutrient concentration in the aquatic environment. Needless to say that the productivity/quality of wetland is dependent on all these factors (Westlake *et al.* 1998). Thus, physico-chemical character is an important criterion for prioritizing wetlands for conservation. Moreover, for developing a monitoring protocol for wetlands, baseline information on physico-chemical aspect is necessary to detect any change in wetland functions. This study aims to gather benchmark ecological information on the status of high altitude wetlands of Ladakh for conservation prioritization.

9.2 Objectives

The major objective of the present study was to generate quantitative baseline information on the status of wetlands and their associated avifauna. Following broad objectives were identified.

1. Assessment of physico – chemical quality and nutrient status,
2. Extent of use by breeding and non-breeding birds and
3. Extent of human use of wetlands/lakes.

9.3 Study area

Ladakh represents the Trans-Himalayas sector of the Himalayan mountain chain. The area receives less than 100 mm annual rainfall with little snow, therefore it is recognized as cold desert. Most of the lakes and streams of Ladakh are of glacial origin and remains frozen during November to March. The entire Rupshu valley and the Changthang region are full of lakes and marshes. This part of the Ladakh consists of southwest extension of Tibetan Plateau. There are around 13 major lakes found in the Changthang region. Most of the marshes are found along the major rivers in the Changthang regions. The prominent ones are Hanle, Chusul, Chumur and Shey. Apart from these lakes and marshes Ladakh has some major river systems; Shyok and Nubra rivers along the Karakoram range to the north, Indus river systems passing through east to west in entire central Ladakh, and three smaller river systems such as Zaskar, Suru and Dras with large number of tributaries in the Zaskar ranges.

9.3.1 Lakes

During the present year following lakes and rivers were surveyed for their physicochemical characters and biological values, especially for waterfowls.

- (1) Tso Moriri , (2) Tso Kar, (3) Startsapuk Tso, (4) Thatsangkaru, (5) Kiyun Tso I (6) Kiyun Tso II (7) Pangong Tso

9.3.2 Rivers

(1) River Indus between Nimo and Dah (2) River Nubra between Panamik and Sumur (3) River Shyok between Sumur and Hundar (4) River Zaskar near the confluence at Nimo (5) River Suru above and below the Kargil town

Reconnaissance was also carried out at the following wetlands/marshes for planning future studies: (1) Marshes at Shey, (2) Marshes at Hanle, (3) Marshes at Chusul (4) Marshes in the Parma valley

9.3.3 Description of the Lakes

Tso Moriri: It is located about 215 km. in the south-east of Leh at an altitude of about 4595 m. The lake is fed by a number of small glacial streams and have no external drainage. One stream Phirsa flows into the lake from south-west, the other stream enters from the northern end of the lake as a large estuarine channel at Peldo. Another stream enters the lake from the west near village Korzok which is the only settlement around the lake. The lake is about 19 km long along the north-south direction and its maximum width is about 9 km. The surface area of the lake was estimated to be 148 km² by Hutchinson (1932) but the recent report of SAC, Ahmedabad, based on remote sensing puts the area at 138 sq. km.

Tso Kar: It is located in the Rupshu area of Changthang at an altitude of around 4500 m. Extensive areas of wet meadows and borax bogs surround the lake. The lake is a salt water lake with large heaps of salt around it. The lake receives water from the Startsapuk Tso through a small channel, which connects both the lakes. The lake also receives some water from the northern end. Tso Kar is irregularly L-shaped, its greatest length being 8 km. and greatest breadth at the eastern end 4 km (Gopal 2000). Most of the lake is about 2m deep although a section of the lake at the eastern end is up to 9 m deep. The waters of the Tso Kar contain considerable amounts of potassium and sulfate. The lake remains frozen from the months of November to March.

Startsapuk Tso: It is located at an altitude of about 4500 m and is a freshwater lake, which derives most of its water from the mountains to the south of the lake. The water of the lake is discharged into Tso Kar to the north through a small channel, which connects both the lakes. The lake is an elongated patch of water body about 4 km long and 1.6 km wide with an area of about 2.5 km² (Gopal 2000). Maximum depth of the lake is 2 m whereas most of the lake is about 1m deep. The lake holds far-reaching importance in relation to the migratory birds, particularly at the fall of the migration period i.e. in October, during which the lake gets crowded with migratory waterfowls (Namgyal 2000).

Lake Thatsangkaru: It is a small lake situated at an altitude of 4,500 m at the northern end of the Tso Moriri in the Rupshu area closer to Shak Shang. It is approximately 4.84 km² in area with brackish water. Local Changpa graziers extensively use the draw down areas of this lake.

Kyun Tso I and II: These are two small lakes situated at about 5029 m altitude with an area of 4.93 and 4.74 km² respectively. These lakes are situated about 20 km at the south of Rupshu at 33° 15' latitude and 77° 55' longitude.

Pangong Tso: This lake is situated northeast to Chushul at 4218 m altitude and lies in between the Karakorum range in the northeast and the Ladakh range in the southwest. It is approximately 136 km long extending into Western Tibet. The length of this lake within Indian Territory is around 45 km.

9.3.4 Description of the rivers

Shyok: The Shyok originates from Rimo glaciers and flows south to be joined by the Chong Kumdan river. It turns north westwards and is joined by the Nubra River near Khalsar and runs towards Baltistan. Between Khalsar and Hunder the Shyok river is quite broad up to 700 m wide.

Nubra: The Nubra river drains the long Siachen Glacier, flows to the south, and is joined by several glacial streams. Near Khalsar it merges with the Shyok. During summer it flows very fast because of melting glaciers, while in winter it can be crossed easily in many places.

Indus: The Indus originates in the vicinity of Mansarovar lake and flows northwest. It enters Ladakh at Demchok and continues flowing northeast. Blocked by the Pangong range the river takes a sharp westerly turn and flows in vast plains of Ladakh. Past Leh it runs to Khalsi and goes ahead to Baltistan. Its main tributary in Ladakh, the Zaskar river merges with it near Nimo. The Shyok joins the Indus little before Skardu, then turning south it runs through Pakistan to flow into the Arabian Sea near Karachi.

Zaskar: merging of the Tsarap, Lingti Chu and the Doda rivers near Padam form the Zaskar river. From Padam it flows north through several deep gorges through the Zaskar ranges. The Markha river joins it in the east.

Suru: The Suru river drains large area near Kargil. Water from the northwest slopes of Pensi La are fed by Lalung, Chilung and Dalung glacier systems to form the Suru river, Flowing north it passes through Kargil and merges with the Shingo river which subsequently joins with the Indus near Marol.

9.4 Methodology

The study was carried out during July, 2000. Lakes in the Changthang region were surveyed during 9-20 July. The detailed methods adopted for each component have been described below.

9.4.1 Physicochemical analysis

Triplicate water samples were collected from the littoral zone of all the lakes. During the water collection ambient temperature was recorded. The water samples were examined for pH, Electric conductivity (EC) and TDS by using direct reading probes (APHA, 1992). Turbidity was measured with the help of portable water quality analyzer (Make: ELICO India). Dissolved oxygen was quantified by modified Winkler Azide method (APHA, 1992). Forms of nitrogen (NH_4 , NO_3 and NO_2), phosphate, calcium and sulphite were quantified by using RQ flex (Make: Emerck) reflectoquant portable meter. Remaining samples were transported to laboratory for the quantification of alkalinity and hardness by titrimetric method (APHA, 1992).

9.4.2 Distribution of breeding birds

For estimating breeding bird abundance at each sampling point 1000 m of the shoreline was walked and number of breeding birds within 200 m from the shore were counted. The sampling points were selected randomly. At each point shoreline characteristics such as shoreline substrate, vegetation characteristics and ground cover was recorded. Evidence of breeding was recorded from the on-site examination of nests, behaviour of birds and from fledglings within the vicinity of the wetlands.

9.4.3 Distribution of otter

Indirect evidences of the presence of otters such as foot prints, faecal deposits, den and resting sites were searched along the main rivers such as River Indus between Nymo and Dah, River Nubra between Panamik and Sumur, River Shyok between Sumur and Hundar, River Zaskar near the confluence at Nimo, (5) River Suru above and below the Kargil town and also along the lakes and marshes. At each site 500 m of the bank within a 25 m strip along the water edge was searched. Apart from this, local people were interviewed to know if otters were seen in the area.

9.4.5 Extent of human use of wetlands/lakes.

During the survey information was also gathered on the possible human use and the disturbance factors that may affect the wetlands and its associates. This information was gathered by interviewing the locals, guides and by on-site observations. The following parameters were recorded: Village within 1000 m of lake, Ribos (Grazing camps), Army camps/units, Tourist camps, Tourist vehicles and Pack animals, Grazing by livestock and stone collection or other construction activities. Each parameter observed occurring at a wetland was assigned a score of one point, this was later summed up to find out the extent of disturbance factors.

9.5 Results

Lakes

All the lakes surveyed are of glacial origin. The various geographical attributes of the seven lakes surveyed are given in Table 1.

Table 1: Attributes of the surveyed lakes

Name	Altitude (m)	Area (km ²)	Perimeter (km)
Tso Kar	4530	19.50	23.3
Startsapuk Tso	4530	2.5	NA
Tso Moriri	4511	142.90	69.51
Thatsangkaru	4500	4.84	9.02
Kyun Tso - I	5029	4.93	8.5
Kyun Tso - II	5029	4.74	9.77
Pangong Tso (Indian part)	4218	176.21	106.99

Source: Anon, 1997

Mean level of water quality parameters in seven high altitude lakes has been given in Table 2. To summarize, the minimum turbidity level was observed in Kyun Tso - I (50.37 NTU) and highest in Tso Kar (0.53 NTU). Amongst the forms of solids, level of total dissolved solids (TDS) was found to be higher than total suspended solids (TSS) for Tso Kar, Thatsangkaru and Pangong Tso (Table 2). Lowest Total Solids (TS) load was observed in Kyun Tso - I (245.33 mgL⁻¹) followed by Startsapuk Tso, Kyun Tso - II, Thatsangkaru, Tso Moriri, Pangong Tso and highest for Tso Kar (36856.00 mgL⁻¹). Similar patterns were observed in case of total suspended solids (TSS).

Electrical conductivity and salinity was observed to follow the same trend with its lowest value in Kyun Tso - I and highest in Tso Kar. Value of these parameters in Pangong Tso was observed intermediate as compared to above mentioned lakes. The lowest pH (7.82) was observed for Kyun Tso - I and highest pH (9.71) for Startsapuk Tso. The total alkalinity level was also lowest in Kyun Tso - I (75.00 mgL⁻¹) but highest 1683.33 mgL⁻¹ for Pangong Tso. At the same time alkalinity due to bicarbonate ion (HCO₃) was found to be absent in all the six lakes except Tso Kar where it was mainly due to presence of HCO₃ and carbonate ion (CO₃). Except Startsapuk Tso, Kyun Tso - I & II the reason for alkalinity in all the lakes were due to both CO₃ and hydroxyl ion (OH) where it is only due to OH. Water hardness was observed lowest in Kyun Tso - I (75.00 mgL⁻¹) and highest (9255.00 mgL⁻¹) for Tso Kar.

The lowest mean DO level (5.16 mgL⁻¹) was observed in Pangong Tso and highest DO level (10.21 mgL⁻¹) in Startsapuk Tso. Phosphate level in Kyun Tso - I was observed lowest (1.67 mgL⁻¹) followed by, 5.00 mgL⁻¹ (Kyun Tso - II), 5.33 mgL⁻¹ (Tso Moriri), 7.00 mgL⁻¹ (Tso Kar), 7.67 mgL⁻¹ (Pangong Tso). The highest concentration was found for Thatsangkaru (11.67 mgL⁻¹) and Startsapuk Tso (12.33 mgL⁻¹). Sulphite was almost absent in Pangong Tso where as its highest concentration was observed in Kyun Tso - I.

Amongst three forms of nitrogen, nitrite ($\text{NO}_2\text{-N}$) was observed only in Startsapuk Tso (0.50 mgL^{-1}) and Thatsangkaru (0.53 mgL^{-1}). Concentration of nitrate ($\text{NO}_3\text{-N}$) was more than the ammonia and the highest (4.67 mgL^{-1}) and lowest (1.00 mgL^{-1}) concentration was observed for Startsapuk Tso and Kyun Tso – I, respectively.

Table 2 Mean level of water quality parameters in seven high altitude lakes of Ladakh ($\pm$ SE)

Parameters	Lakes						
	Tso Kar n = 3	Startsapuk Tso n = 3	Tso Moriri n = 3	Thatsangkaru n = 3	Kyun Tso I n = 3	Kyun Tso II n = 3	Pangong Tso n = 3
Temp. ($^{\circ}\text{C}$)	18.63 ± 1.58	22.00 ± 1.59	14.37 ± 0.52	19.13 ± 1.36	14.90 ± 0.05	14.57 ± 0.12	18.63 ± 0.82
Turb. (NTU)	0.53 ± 0.14	4.35 ± 1.92	3.42 ± 1.60	11.48 ± 5.0	50.37 ± 21.35	24.08 ± 1.44	5.23 ± 3.31
TS	36856.0 ± 4400.0	433.33 ± 88.19	4933.33 ± 3099.64	4700.0 ± 550.76	245.33 ± 22.73	1033.66 ± 364.93	8655.33 ± 786.42
TDS	21146.66 ± 139.68	184.96 ± 1588.84	534.33 ± 5.58	2785.33 ± 292.73	41.92 ± 1.66	125.80 ± 1.74	4876.33 ± 245.38
TSS	15709.33 ± 4382.22	248.37 ± 96.06	4399.0 ± 3094.88	1914.67 ± 324.44	203.41 ± 21.13	907.87 ± 366.66	3779.0 ± 608.45
E. Cond. (mS)	58.63 ± 1.17	0.41 ± 0.09	1.39 ± 0.05	6.29 ± 0.54	0.11 ± 0.001	0.31 ± 0.004	11.06 ± 0.50
Salinity (ppt)	39.33 ± 0.67	0.0	1.0 ± 0.0	3.66 ± 0.33	0.0	0.0	6.33 ± 0.33
Alkalinity	1325.0 ± 38.19	233.33 ± 60.09	450.0 ± 0.0	1458.33 ± 204.29	75.00 ± 14.43	191.67 ± 22.05	1683.33 ± 122.76
Hardness	9255.0 ± 57.95	200.0 ± 62.91	783.33 ± 16.67	536.67 ± 56.0	63.33 ± 7.26	163.33 ± 7.26	2116.67 ± 16.67
PH	8.74 ± 0.01	9.71 ± 0.48	8.85 ± 0.04	9.34 ± 0.03	7.82 ± 0.02	8.86 ± 0.01	9.09 ± 0.009
DO	7.34 ± 2.35	10.21 ± 1.92	7.57 ± 0.00	6.54 ± 0.19	6.88 ± 0.19	6.99 ± 0.11	5.16 ± 0.0
$\text{PO}_4\text{-P}$	7.0 ± 1.52	12.33 ± 2.40	5.33 ± 1.45	11.67 ± 0.33	1.67 ± 0.33	5.0 ± 0.58	7.67 ± 2.33
$\text{SO}_3\text{-S}$	6.67 ± 3.53	8.67 ± 4.37	12.67 ± 1.76	10.33 ± 0.33	14.0 ± 1.73	13.33 ± 1.20	0.0
$\text{NH}_4\text{-N}$	0.17 ± 0.06	0.33 ± 0.03	0.30 ± 0.11	0.40 ± 0.0	0.13 ± 0.03	0.30 ± 0.58	0.30 ± 0.58
$\text{NO}_3\text{-N}$	2.67 ± 0.33	4.67 ± 0.33	4.00 ± 0.0	4.0 ± 0.0	1.00 ± 0.0	3.67 ± 0.33	1.33 ± 0.67
$\text{NO}_2\text{-N}$	0.0 ± 0.0	0.50 ± 0.03	0.0	0.53	0.0	0.0	0.0
Ca	19.47 ± 1.37	13.70 ± 4.97	8.23 ± 0.48	3.33 ± 0.12	14.83 ± 0.18	17.57 ± 0.14	4.87 ± 0.18
Mg	2246.79 ± 14.96	40.45 ± 17.84	186.12 ± 3.78	126.21 ± 12.77	6.49 ± 1.70	29.46 ^a ± 1.91	513.50 ± 3.99
HCO_3	191.67 ± 30.05	0.0	0.0	0.0	0.0	0.0	0.0
CO_3	1133.33 ± 66.67	0.0	200.0 ± 0.0	775.0 ± 137.69	0.0	0.0	1133.33 ± 60.09
OH	0.0	233.33 ± 60.09	250.0 ± 0.0	683.33 ± 66.67	75.0 ± 14.43	191.67 ± 22.05	550.0 ± 66.14

* units of all parameters are expressed in mgL^{-1} otherwise mentioned; $\pm$ Standard Error of mean

Amongst the metals, concentration of Mg (even more than Ca) was higher in the water of all the lakes. The highest (19.47 mgL⁻¹) and lowest (3.33 mgL⁻¹) concentration of Ca was observed in Tso Kar and Thatsangkaru respectively whereas the concentration of Mg was lowest (6.49 mgL⁻¹) in case of Kyun Tso - I.

Table 3. Mean level of water quality parameters in five major riverine ecosystem of Ladakh

Parameters	Name of Rivers				
	Indus n = 18	Shyok n = 6	Nubra n = 3	Zaskar n = 3	Suru n = 6
pH	8.31 ± 0.17	8.35 ± 0.01	8.75 ± 0.03	8.56 ± 0.15	8.25 ± 0.13
E.Cond (µS)	0.15 ± 0.02	0.18 ± 0.01	0.13 ± .00	0.14 ± 0.33	0.14 ± 0.03
TDS	66.37 ± 10.17	79.12 ± 6.51	26.85 ± 0.01	53.64 ± 0.26	47.76 ± 0.96
TS	5106.5 ± 7827.6	4511.7 ± 547.84	2025 ± 25	2020.0 ± 26.458	2031.7 ± 25.820
TSS	5040.1 ± 7818.5	4432.5 ± 554.35	1998.2 ± 24.99	1966.4 ± 26.4311	1983.9 ± 5.6953
Turb (NTU)	1336.9 ± 1706.5	5449.9 ± 553.6	2785.5 ± 0.5033	2426.0 ±1.00	268.85 ± 159.38
DO	7.54 ± 3.22	8.140 ± 0.4383	10.18 ± 0.010	10.18 ± 0.0208	10.79 ± 0.2198
Ammonia	0.46 ± 0.08	0.6883 ± 0.1722	0.5333 ± 0.06	0.5000 ± 0.01	0.4667 ± 0.2658
Nitrite	0.167 ± 0.24	00.00 ± 00.00	00.00 ± 00.00	00.00 ± 00.00	00.00 ± 00.00
Nitrate	3.55 ± 0.17	3.55 ± 1.72	00.0 ± 00.00	1.66 ± 0.57	1.50 ± 0.54
Phosphate	7.33 ± 4.39	7.33 ± 4.39	5.50 ± 1.04	3.66 ± 0.57	3.00 ± 2.28
Sulfite	3.50 ± 5.10	3.50 ± 5.10	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Calcium	28.65 ± 10.39	28.65 ± 10.39	100.03 ± 158.32	26.30 ± 0.26	41.32 ± 0.97
Magnesium	17.37 ± 18.18	17.37 ± 18.18	11.33 ± 0.38	8.58 ± 0.025	8.56 ± 4.04
Hardness	144.33 ± 80.42	144.33 ± 80.42	142.50 ± 19.68	101.66 ± 2.88	140.83 ± 5.94
Alkalinity	99.17 ± 26.30	99.16 ± 26.30	142.50 ± 19.68	76.66 ± 2.88	94.16 ± 40.42

* units of all parameters are expressed in mgL⁻¹ otherwise mentioned; ± Standard Error of mean

Among the rivers the mean TDS, TS, DO, Nitrate, Phosphate, Calcium, Magnesium hardness and alkalinity varied considerably (Table 3). This may be due to intense flood in these river systems.

Distribution of breeding birds

During the survey 16 species of water birds from the Changthang region were recorded (Table 4) of which seven species were breeding in various wetlands.

Evidences of seven species of birds breeding at Startspuk Tso were found, followed by Tso Moriri (6 species), Tso Kar (5) Pangong Tso and Kiyun Tso II (4) and Thatsangkaru (2). No evidences of breeding of any bird species from the lake Kyun Tso-I were observed.. Evidences of great crested grebe and black necked crane were recorded from Startsapuk Tso and Tso Moriri only and evidence of common merganser was found from Pangong Tso and from the Indus river down stream 15 km from Mahe bridge. Colonies of juvenile brown headed gulls were recorded from Startspuk Tso and Pangong Tso indicating large scale breeding around these lakes.

In respect to Black-necked cranes, we observed one breeding pair at Startsapuk Tso, two in flight between Tso Kar and Tso Moriri in the Puga valley, one breeding pair with eggs at Tso Moriri and one breeding pair with chicks at Lunghak (Hanle Valley). During the survey the forest department and the Army personnel informed us that three pairs of Black-necked cranes were breeding at Hanle, one pair each at Chusul and Chumur. However, we failed to see them during our visit to Hanle and Chusul, because of time constraint. It is important to mention here that this is the first report of nesting of the endangered Black-necked crane from Tso Moriri. However, during our stay we were informed by the watchman of Tso Moriri that the hatching do not occurs as the eggs get washed away because of floods due to unexpected rains.

Table 4. List of aquatic birds seen (○) and evidences of their breeding (*) recorded during the survey of wetlands and aquatic ecosystem of Changthang region (Cold Desert Sanctuary) in Ladakh

Sl. No.	Species	Lakes													
		Tso Kar		Startsapuk Tso		Tso Moriri		Thatsang karu		Kyun Tso-I		Kyun Tso-II		Pangong Tso	
1	Bar-headed goose	○	*	○	*	○	*	○	*	X	-	○	*	○	*
2	Ruddy shelduck	○	*	○	*	○	*	○	*	X	-	○	*	○	*
3	Ferriginous duck	X	-	○	-	○	-	X	-	X	-	X	-	X	-
4	Common pochard	○	-	○	-	X	-	X	-	X	-	X	-	X	-
5	Gargeny	X	-	○	-	X	-	X	-	X	-	X	-	X	-
6	Common merganser	X	-	X	-	X	-	X	-	X	-	X	-	○	*
7	Black-necked crane	X	-	○	*	○	*	X	-	X	-	X	-	X	-
8	Common red shank	○	*	○	*	○	-	○	-	X	-	○	*	○	*
9	Common sandpiper	○	-	○	-	○	*	X	-	X	-	X	-	X	-
10	Temminck's stint	○	-	X	-	X	-	X	-	X	-	X	-	X	-
11	Lesser sand plover	○	*	○	*	○	*	○	-	X	-	○	*	X	-
12	Brown-headed gull	○	*	○	*	X	-	○	-	X	-	X	-	○	*
13	Common tern	○	-	○	-	○	-	X	-	X	-	X	-	X	-
14	Whiskered tern	○	-	X	-	○	-	X	-	X	-	X	-	X	-
15	Great crested grebe	X		○	*	○	*	X	-	X	-	X	-	X	-
16	Citrine wagtail	○	-	○	-	X		X		X		X		X	
	TOTAL	11	5	13	7	9	5	5	2	0	-	4	4	5	4

Abundance/encounter rate (per km) of birds

We present encounter rate of six common breeding birds (Table 5). Barheaded geese were found to be nesting in all the lakes except, Kyun Tso I. The mean encounter rate of Barheaded geese varies between 3.5 to 17. It was lowest for Thatsangkaru and highest for Kyun Tso II. The encounter rate for Ruddy shelduck varied from 1-58. It was highest for Startsapuk Tso and lowest for Pangong Tso.

Table 5. The encounter rates of most common breeding birds species found along the seven high altitude lakes of Ladakh.

Species	Lakes					
	Tso Kar N=3	Startsapuk Tso N=3	Tso Moriri N=4	Thatsangkaru N=2	Kyun Tso II N=2	Pangong Tso N= 3
Bar headed geese	8 + 4.6	5.3 + 2.6	7 + 3	3.5 (0-7)	17 (8-26)	7.3 + 4.66
Ruddy shelduck	12.4 +4	58 +46.05	2 + 1.15	3.5 (0-7)	4.5 (0-9)	1 (0-2)
Common red shank	1.33 ± 0.66	11.33 ± 9.4	2 ± 1.15	2.5 (1-4)	1 (0-2)	3.33 ± 2.4
Lesser sand plover	0.33 ± 0.33	0.33 ± 0.33	0.33 ± 0.33	1.5 (0-3)	4.5 (0-9)	0.33 ± 0.33
Brown headed gull	20.6 ± 19.67	1.33 ± 0.66	0	0	0	12 ± 4.96

+ = Standard Error of mean

Distribution of otter

During the survey many people including the Wildlife Department Personnel confirmed the presence of otters from the survey stretches of Indus, Shyok and Nubra rivers. However, we could not confirm the presence of otter, largely because of wrong timing of survey, with respect to otters (as most rivers were in flood, thus obliterating otter evidence). Some evidences of otter presence such as den sites from the Indus between Leh and Nimo were found, but all these evidences were old, possibly of late winters (March-April).

Human use and resultant disturbance

The overall disturbance score was highest for Tso Kar and Tso Moriri (7) followed by Startsapuk Tso, Thatsangkaru and Pangong Tso. Both, Kyun Tso I and II were the least disturbed among all the seven lakes (Table 6). Among the eight identified human use parameters which could pose potential threats to the wetlands and their associates are tourism and the associated negative impacts such as problems of solid wastes and excessive grazing by livestock.

Table 6. Human use and resultant disturbance at the seven lakes in the Changthang region of Ladakh.

Human use Disturbance	Lakes						
	Tso Kar	Startsapuk Tso	Tso Moriri	Thatsangkaru	Kyun Tso-I	Kyun Tso-II	Pangong Tso
Village within 1000 m of lake	0	0	0	X	X	X	0
Ribos (Grazing camps)	0	0	0	0	0	0	0
Army camps/Units	X	X	0	X	X	X	0
Tourist camps	0	0	0	0	X	X	X
Tourist vehicles	0	0	0	0	X	X	0
Pack animals	0	0	0	0	X	X	X
Grazing by livestock	0	0	X	0	0	0	0
Stone collection/construction	0	X	0	X	X	X	X
Total scores	7	6	7	5	2	2	5

0 = 1 point, X = 0 point

9.7 Discussion

The variation in physico-chemical properties of any aquatic ecosystem depends upon various factors such as ambient water temperature, activity of micro organisms, physical, chemical and biological reactions prevailing in the system. The high and low turbidity level for Kyun Tso - I and Tso Kar respectively is not explainable at this stage even the load of TSS was observed high in Tso Kar and low in Kyun Tso - I. This is a noteworthy finding as Gereta and Wolanski (1998) reported the role of fine sediments in suspension as a major factor for reducing the productivity of wetlands of Serengeti National Park, Tanzania.

During the present survey a remarkably high concentration of dissolved solid was observed in the case of Tso Kar thus making the lake saline (Tilzer and Serruya, 1990). As electrical conductivity is the measure of capacity of a substance to conduct electrical current (Trivedy and Goel, 1986), it showed a similar trend as of Total Solids (TS) and TDS. Alkalinity was observed only in the form of bicarbonate (HCO_3) in the water of Startsapuk Tso, Kyun Tso - I & II. Dissolved Oxygen (DO) is one of the most important parameters for water quality assessment and reflects the physical and biological processes prevailing in the water. Presence of DO is essential to maintain the higher life forms in water. Sharma and Pande (1998) reported that a minimum of 5 mgL^{-1} oxygen is required for fish fauna although certain desert fish such as pup fish can survive in low oxygen tension e.g. $0.1 - 0.4 \text{ mgL}^{-1}$. None of the lake water showed the DO level below 5 mgL^{-1} .

The hardness of water depends mainly upon the concentration of alkaline earth metals along with anions such as HCO_3 , sulphate and chloride (Cl). The water of all the lakes is hard to very hard except Kyun Tso - I which has concentration $<75 \text{ mgL}^{-1}$. According to the EPA (1976), the effect of hardness on aquatic life is related to the ions causing the hardness rather than hardness itself.

The ecological interest of phosphorus has arisen because of its major role in biological metabolism and relatively small amounts of phosphorus present in the hydrosphere. Total phosphate concentration is considered to be a nutrient of major importance in production process and the increased application of fertilisers, use of detergents and domestic sewage greatly contribute to heavy loading in water (Golterman, 1975) that ultimately leads to eutrophication process. Noteworthy is concentration of phosphorus in the lakes without any major source. According to EPA (1976) the concentration of phosphorus should not exceed $50 \text{ } \mu\text{gL}^{-1}$ in any tributary or lake and $25 \text{ } \mu\text{gL}^{-1}$ within these main resources.

Presence of all the three forms of nitrogen (ammonia, nitrite and nitrate) was observed only in the water of Startsapuk Tso and Thatsangkaru. There are no mineral sources of nitrite and it is a very unstable ion, which gets converted either into ammonia or nitrate depending upon the conditions prevailing in the water. Therefore, presence of nitrite in Startsapuk Tso and Thatsangkaru, is an indication of the availability of

partially oxidised nitrogenous substances. Amongst the various forms of nitrogen, nitrate is the highest oxidised form and apart from the organic and nitrogenous waste atmospheric nitrogen fixation is also a significant contributor to nitrates in the waters.

On the basis of this preliminary study it is difficult to make any conclusion on the water chemistry or specific reason for the variation in the limnology of lakes. But based on the TDS concentration (Tilzer and Serruya, 1990) the system of lakes in the Changthang Region can be grouped into following salinity types:

Salinity type	TDS (mgL ⁻¹)	Lakes
Fresh	<2,000	Startsapuk Tso, Kyun Tso-I & II, Tso Moriri
Brackish	2,000 – 20,000	Thatsangkaru, Pangong Tso
Saline	20,000 – 40,000	Tso Kar

Distribution of breeding birds

During a study on the breeding ecology of the black-necked cranes, Pfister (1998) recorded 16 species of water birds from the Chang Thang region in the month of July 1997. During an intensive survey in August 1999, 34 species of birds from four lakes viz. Numro Sumdo, Tso Moriri, Startsapuk Tso and Tso Kar were recorded by Humbert-Droz (2000) of which 26 species were recorded from Tso Kar alone and 20 species from Startsapuk Tso. During the present survey 16 species of water birds were recorded from the Chang Thang Region. However, we did not record Northern pintail (*Anas acuta*), Green sand piper (*Tringa ochropus*) and Wood sand piper (*T. glareola*) which was recorded by Pfister (1998) from the same survey area. Three other species which were not recorded by Pfister (1998) in the month of July were recorded during this survey in July 1997. These are Ferruginous duck, Common pochard and Gargeny. These species were however recorded by Pfister (1998) during other months from the same area.

Of the total 16 species of wetland birds recorded during this survey 13 species were recorded from Startsapuk Tso alone and 11 species from Tso Kar. The two species which were not recorded from Startsapuk Tso, but from Tso Kar were Black-necked crane and Great Crested grebe. From all these observations it is concluded that Startsapuk Tso and Tso Kar or the entire Tsokar Basin plays a vital role for the wetland birds in the Changthang region. However, both Tso Kar and Startsapuk Tso are getting increasingly disturbed because of tourist pressure and human use activities.

Except black necked cranes, the differential observation in the number and abundance of wetland birds recorded during this study could be due to our rapid survey method. A detailed bird monitoring study from March-October is required to assess the habitat use by migratory and resident birds of the Changthang region.

During the study on the breeding ecology of the black-necked cranes, Pfister (1998) recorded 12 sites in the Changthang region as breeding ground for endangered black-necked cranes and refuted any possibility for Tso Moriri to be one of the breeding

ground for Black-necked cranes. However, this survey established that Black-necked cranes have started nesting on the northern edge of Tso Moriri.

From the survey we observed that at least six species of birds are breeding around Tso Moriri. Apart from this it is also one of the most important breeding ground for Barheaded goose and Ruddy shelduck. However, at least the northern part of Tso Moriri is being affected by the presence of village Korzok, new ITBP field station and large number of Ribos and grazing camps in its catchment.

In the Rupchu and Changthang area there are around 41 villages with a population of around 9500. They have approximately 140,000 domestic livestock, 90% represented by sheep and goat and remaining 10% by domestic yak, ponies and zo. These animals extensively graze around these lakes and particularly along the marshes and wet meadows directly competing with wild ungulates. Large herds of goats and sheep do disturb the nesting birds, trample the eggs and the accompanying dogs predate upon eggs, chicks and fledglings.

From our study we conclude that instead of developing conservation measures for individual lakes, an integrated landscape approach is required to conserve the complex system of lakes and wetlands in the Changthang region.

Though many people including the Wildlife Department Personnel confirmed the presence of otter in the survey stretches of Indus, Shyok and Nubra rivers, we could not confirm the presence of otters, largely because of wrong timing of survey. During the survey all the rivers were flooded making the survey timing unsuitable for detecting the presence of otter signs. It is proposed to conduct the otter survey during early (October – November) or late winter (March – April).

Future plans

For the next year we propose to (1) estimate the primary productivity of seven lakes (2) monitor bird species diversity and, (3) conduct intensive survey of the marshes of the entire Changthang region

References

- Anon (1993).** Directory of Indian Wetlands, WWF, AUB.
- APHA (1992).** Standard methods for the examination of water and wastewater, 18th edition, American Public Health Association, Washington D.C.
- Cowardin et al. (1979).** Classification of wetlands and deep-water ecosystems of the United States of America. U.S. Geological Service
- EPA (1976).** Quality criteria for water. U.S. Environmental Protection Agency, Washington, DC, 20460, 501pp.
- Golterman, H.L. (1975).** *Physiological Limnology*. Elsevier Scientific Publication Co. New York. 489 pp.
- Greta, E. and E. Wolanski. (1998).** Wildlife - water quality interactions in the Serengeti National Park, Tanzania. *African Journal of Ecology*, **36**: 1 – 14.
- Humbert-Droz, Blaise (2000).** Protection of the Tso Moriri – Upper Spiti region, Indian-Trans-himalayas. Biodiversity, tourism impacts and prospects for conservation. National consultation, Conservation of high altitude wetlands. Background documents. WWF-Delhi.
- Pfister, O (1998).** The breeding ecology and conservation of the Black-necked crane. Unpublished report. 110 pp.
- Tilzer, Max M. and Serruya, Colette (1990).** Large Lakes. Springer-Verlag, Heidelberg, 23pp.
- Trivedy, R.K and Goel, P.K. (1986).** *Chemical and biological methods for water pollution studies*. Environmental Publications, Karad, INDIA.
- Wetzel, R.G. 1975.** *Limnology*, W.B. Saunders Co., Philadelphia, USA. 743 pp.

Acknowledgements

Funds for this study were provided by the Project Collaborative Ladakh Field Research Station Ladakh. We acknowledge the help and cooperation extended to us by the Investigators of the project, Wildlife Department, Jammu & Kashmir, Forest Department, Jammu & Kashmir and District Administration, Ladakh. We appreciate the support provided to us by Col. D.P. Atrey, Director, FRL and his team and Shri R.K. Tiwari, IFS, DFO, Leh and Shri Rauf Zargar, Wildlife Warden, Ladakh and his team in organizing the field survey.

Patterns of Livestock Depredation by Wild Animals in Zanskar, Ladakh

by R. Jaypal

10.1 Introduction

Human - wildlife conflicts in various forms - viz. crop raiding & damage, human casualties, and livestock depredation, constitute a core issue in wildlife conservation and management. Though these problems are not of recent origin, there is enough evidence pointing to an increased rate of such hostile encounters these days (Sawarkar, 1986) possibly as a result of increased encroachment by human activities. With the creation of Protected Area (PA) network, which seeks to delineate sites free of human interference and exploitation, there is a growing sense of alienation as the people living next to forests have become less empathetic towards the cause of wild animals (Kothari et al., 1989; Rodgers, 1989). Ladakh in Trans-Himalaya is one of such fragile ecosystem where human-wildlife conflict is manifest in the form of cattle depredation by wild carnivores. The local economy of the Trans-Himalayan landscape is largely livestock-based, as the people are essentially agro-pastoralists. Hence the problem of cattle losses to wild animals assumes both economic and conservation significance in the Trans-Himalaya (Mishra, 1997). Though several conservation plans have explicitly recognized the need for addressing this issue (e.g., Fox et al., 1994; Jina, 1995; Sabarwal, 1998), paucity of cattle-kill data and other relevant socio-economic information from Ladakh is a major constraint in drafting apt policies. Further, very few studies (e.g., Mishra, 1997; Bhatnagar et al., 1999) have actually attempted to quantify the cattle depredation rate and the consequent economic losses.

This survey was designed to collect first-hand information on the patterns of livestock predation by wild animals in Zanskar region, Ladakh. Zanskar being endowed with vast stretches of high-altitude riverine pasturelands, support a high density of livestock population and grazing camps in summer. The precipitous mountain ranges of this region are also home to wild carnivores ranging from Tibetan Wolf to Snow Leopard, and livestock form their major prey in summer owing to a scarce population of wild prey animals (Chundawat & Rawat, 1994; Jackson, 2000). These hostile encounters have given rise to increased human-wildlife conflicts in the region, often leading to killing of wild animals by people through trapping, meat-poisoning and other means particularly in the Upper Suru valley (Nath, 1982). However, information on number of cattle depredated and patterns of predation in Zanskar are scanty, as there were few studies or surveys in the past. Hence the present survey, though limited in its scope and depth, is an important addition to our existing knowledge of Ladakh ecology.

10.2 Objectives

The objectives of this survey were:

- ◆ To assess rate and frequency of cattle depredation by wild animals in Zanskar, and
- ◆ To study livestock prey choice of wild carnivore species.

10.3 Study Area

Zanskar region refers to the taluk of the same name in the Kargil district of Ladakh, west and south-west of Leh. The landscape is mainly characterized by high-rising precipitous mountain ranges flanking broad river valleys of Suru and Zanskar (Stot + Lunak) rivers. These valleys are covered in summer by vast stretches of wet turf-grass meadows, which form prime grazing lands for livestock, locally known as 'doksas'. The altitude of the region varies from 2800 m (Kargil in Upper Suru) to 7000 m (Nun-Kun peaks). Though the annual precipitation rate is less than 250 mm, it is much higher than Leh (96 mm); as a result, Zanskar mountains are characterized by a number of small to large glaciers (Dhar & Mulye, 1987). Four distinct seasons can be identified: winter (December – April), spring (May – June), monsoon (July – August), and autumn (September – November) (Dhar & Mulye, 1987). The mean temperature varies from 30°C in summer to -30°C in winter.

As stated before, the landscape of the Zanskar region comprises two main river valleys (Jina, 1996):

- ◆ Suru valley (Kargil – Rangdum; approx. area: 2900 sq.km.) and
- ◆ Zanskar valley (Rangdum – Padum – Phutkal; approx. area: 3000 sq.km.).

The administrative headquarters of Zanskar is Padum. According to 1981 census, human population was 8,315 with a decennial growth rate of 20.78 % during 1971-81. Though there are officially 28 villages in Zanskar, the number may well exceed a hundred if we include all the seasonally inhabited villages and cattle-camps (Jina, 1995). Agriculture is the main occupation with about 91% of population dependent on it. As per 1977 census, the Kargil district possesses c. 1.18 lakh livestock, of which sheep & goat alone compose ca. 0.89 lakh (Bhatt, 1997). In Zanskar, the agro-pastoral activities start after 'saka' festival towards the end of March, by which time a multitude of nomadic grazing camps start moving into pasturelands of Suru and Zanskar valleys from Kashmir. Jina (1995) has outlined three altitudinal belts of land-use pattern in Zanskar:

- i. Crop farming (3000 – 4500 m)
- ii. Grazing (3600 – 4500 m) and
- iii. Unused rocky glaciers (>4500 m).

However, the ecological balance that existed between graziers and replenishment of natural resources has, of late, started showing signs of disintegration; the chief factors responsible for such a dismal scenario are (after Jina, 1995):

- i. Overpopulation of livestock and overgrazing
- ii. Slow regeneration rate of food plants in the wild, and
- iii. Increased soil erosion and a resultant decrease in grazing area available.

10.4 Survey Methods

The survey was conducted during June – July 2000 in Zanskar. The prime method used was semi-structured open interviews with the household members; 5 – 10 households were randomly chosen from every village covered by the survey, and information on livestock losses in the years 1999 and 2000 were collected. Information was also sought for the predators involved in all the reported cases. In total, 81 households in 16 villages were covered in the study (*Appendix 1*). During this process, 187 cases of livestock depredation for the year 1999 and 128 cases for 2000 were reported by the interviewees.

The reliability of the information content collected through such open interviews is often suspect. There is a likelihood that the livestock losses might have been exaggerated in the hope of getting more money, as compensation, from the government. Another source of information inaccuracy lurks in the positive identification of the wild predator involved in depredation cases. We recognized these issues and tried to reduce the biases by adopting cross-validation measures. The purpose of the survey was first explained to the interviewees clearly to expel any notion of compensation. This increased the chances of information being genuine, the authenticity of which was verified by cross-referencing to other inmates of the village. In fact, we came across some instances of under-reporting, evidently due to limited recollection. We did not attempt to procure kill-data from the State Department of Wildlife Protection, as the PA network from where such information is usually collected is very sparse in Zanskar. As to the identity of wild predators, the collective wisdom and experience of the Zanskari societies led us to trust their information. Though we used both the 1999 and 2000 data in comparative analysis, only information for the year 1999 were used for pattern analysis as it covered all the four seasons.

10.4.1 Livestock in Zanskar

We grouped the livestock into following six classes for the purpose of analysis:

1. Cattle: It includes cows, dzos, and domestic yaks. Note that buffaloes were absent from Zanskar. Hybrid cattle of yaks and cows are the commoner breed to be found here. The following table lists these hybrids with their local names:

Generation	Parents	Female Offspring	Male Offspring	Fertility
F ₁	yak X pasi	Dzomo	Dzo	sterile
F ₂	yak X dzomo	Garmo	Gar / Garu	sterile
F ₃	yak X garmo	Girmo	Gir	sterile
F ₄	yak X girmo	Lokmo	Lok	sterile
F ₅	yak X lokmo	Tsirgmo	----	sterile
F ₆	yak X tsirgmo	Dimo	Yak	fertile

Source: Jina, 1995

2. Sheep & Goat: The most numerous livestock, and also stated to be the most preferred prey of many wild predators. The breeds include such cherished ones as *pashmina* and *angora* (goats), *changlook* and *marino* (sheep), apart from a large number of scrub varieties.

3. Horses: Zanskar is very famous for its indigenous 'zanskar' horse breed. The trade in horses and equine husbandry are important economic activities of the local people.

4. Donkeys: The donkey population in Zanskar is considerably lower than that of other parts of Ladakh, as horses are the most preferred means of transporting goods.

5. Young animals: Include calves of cattle, foals of donkeys and horses, and lambs of sheep and goat.

6. Poultry: Not popular in Zanskar. A small number of poultry farms are present in Upper Suru valleys.

10.4.2 Wild Predators of Zanskar

The following wild predators were identified in the survey as significantly contributing to the livestock depredation rate in Zanskar:

1. Snow Leopard (*Panthera uncia*): The topmost predator in the food chain. Locally known as 'shan', Snow Leopards are widely thought to prey on Asiatic Ibex in winter and livestock in summer. However, past studies (e.g., Chundawat et al., 1994) and the present survey indicate that they are less dependent on livestock. In Suru valley, most of the cattle depredations by Snow Leopards are reported during December - January and March - June. Nath (1982) estimated the population to be around six for Suru valley and 2-4 for Stot & Lunak valleys.

2. The Tibetan Wolf (*Canis lupus*): Locally known as 'shanku', the people of Ladakh claim that wolves cause the maximum damage to the livestock. They usually attack in packs of 5 - 10. Nath (1982), based on his casual observations, estimated around 100 animals in Suru valley and c. 250 in Zanskar valley. Wolves are also killed frequently by the locals; 'rock-fill traps' with live sheep as bait and 'stone traps' with meat-piece as bait are the commoner methods employed by people to get rid of them (Nath, 1982). Of late, meat-poisoning is being extensively used.

3. Red Fox (*Vulpes vulpes*): A common scavenger of the mountain regions.

4. Brown Bear (*Ursus arctos*): Inhabitants of steep mountainside, Brown Bears are predominantly carnivorous unlike their other cousins. Local people claim that they tend to attack livestock of larger biomass, and occasionally humans fall victim to their attacks.

5. Feral dogs: They are believed to be free-ranging descendents of mongrels kept in large number by the constabulary army in the past. These dogs hunt in packs much in the fashion of wolves. However, the possibility of some of these packs belonging to Asiatic Wild Dogs (*Cuon alpinus*) cannot be ruled out.

6. Golden Eagle (*Aquila chrysaetos*): The only bird of prey that takes toll on young ones of livestock. Said to cause a considerable amount of damage by lifting young calves.

10.5 Results & Discussion

Livestock Depredation: 1999 vs. 2000

Our survey covered the depredation instances for the entire year of 1999 and first six months of 2000. The interviewees were specifically asked for the year in which each case occurred and it helped us to collate the information year-wise. Table 1 and Table 2 provide the summary of these information regarding the number of depredation cases and the actual number of depredated livestock respectively. In total, 315 cases (187 in 1999 & 128 in 2000) and 589 individual kills (382 in 1999 & 207 in 2000) were reported by the 81 households that were interviewed by us.

One crucial aspect of this human-wildlife conflict in Zanskar is the marked seasonality in frequency of livestock depredation; bio-climatic conditions and the subsequent movement of wild prey animals together bring about such variability in the cattle depredation rate. We could not collect seasonality information in our survey, as most of our interviewees were unable to follow up with the seasonal classes or the Gregorian calendar. Alternatively, we performed a Contingency Table Analysis comparing the proportions of depredation cases reported in the year 1999 and 2000; the results indicated a significantly low homogeneity of proportions between 1999 and 2000 (Pearson's Chi-square = 29.7, df = 17, $p < 0.05$). In other words, patterns of livestock depredations over four seasons (i.e., 1999) were significantly different from patterns over two seasons (i.e., 2000). The only other factor that can possibly cause such variation, apart from seasonality, is the likelihood of inaccuracy and inconsistency of livestock-kill information. However, we rule out this possibility as there is a significantly positive degree of concordance between 1999 and 2000 data in predator and livestock choice (Contingency Coefficient = 0.3, $n = 315$, $p < 0.05$). Therefore we infer, with caution, that seasonality influences livestock depredation rate.

		TABLE 1 Number of Depredation Cases									
Year	Livestock	Number of Depredation Cases									
		Goat	Sheep	Cattle	Donkey	Other	Wild	Other	Wild	Other	Wild
1999	Goat	10	15	5	2	1	1	1	1	1	1
	Sheep	12	18	8	3	2	2	2	2	2	2
	Cattle	15	20	10	4	3	3	3	3	3	3
	Donkey	18	25	12	5	4	4	4	4	4	4
	Other	20	28	15	6	5	5	5	5	5	5
	Wild	25	35	20	8	7	7	7	7	7	7
2000	Goat	10	15	5	2	1	1	1	1	1	1
	Sheep	12	18	8	3	2	2	2	2	2	2
	Cattle	15	20	10	4	3	3	3	3	3	3
	Donkey	18	25	12	5	4	4	4	4	4	4
	Other	20	28	15	6	5	5	5	5	5	5
	Wild	25	35	20	8	7	7	7	7	7	7
Total		100	150	60	25	15	15	15	15	15	15

**TABLE 1 Number of livestock-depredation cases in Zanskar (81 households):
A comparison of 1999 (January - December) and 2000 (January - June)**

YEAR	LIVESTOCK	PREDATORS							TOTAL
		Brown Bear	Feral Dogs	Golden Eagle	Red Fox	Snow Leopard	Wolf		
1999	Cattle	3	-	-	-	3	9	15	
	Donkey	-	-	-	-	-	9	9	
	Goat & Sheep	7	12	-	1	16	65	101	
	Horse	2	-	-	-	-	10	12	
	Poultry	-	-	-	15	-	1	16	
	Young Animals	2	1	4	-	5	22	34	
	TOTAL	14	13	4	16	24	116	187	
2000	Cattle	-	-	-	-	-	4	4	
	Donkey	-	-	-	-	-	10	10	
	Goat & Sheep	5	10	-	8	6	32	61	
	Horse	2	-	-	-	-	6	8	
	Poultry	-	-	-	14	-	-	14	
	Young Animals	2	4	10	-	2	13	31	
	TOTAL	9	14	10	22	8	65	128	

**TABLE 2. Number of livestock depredated by wild animals in Zanskar (81 households):
A comparison of 1999 (January - December) and 2000 (January - June)**

A comparison of 1999 (January - December) and 2000 (January - June)								
YEAR	LIVESTOCK	PREDATORS						TOTAL
		Brown Bear	Feral Dogs	Golden Eagle	Red Fox	Snow Leopard	Wolf	
1999	Cattle	3	0	0	0	3	13	19
	Donkey	0	0	0	0	0	11	11
	Goat & Sheep	14	32	0	1	49	141	237
	Horse	2	0	0	0	0	13	15
	Poultry	0	0	0	47	0	7	54
	Young Animals	3	2	7	0	7	27	46
	TOTAL	22	34	7	48	59	212	382
2000	Cattle	0	0	0	0	0	4	4
	Donkey	0	0	0	0	0	11	11
	Goat & Sheep	9	13	0	12	8	58	100
	Horse	2	0	0	0	0	6	8
	Poultry	0	0	0	33	0	0	33
	Young Animals	2	5	18	0	6	20	51
	TOTAL	13	18	18	45	14	99	207

Frequency, Rate and Proportion of Livestock Depredation

We analyzed the livestock depredation data for 1999 (covering all the four seasons) to study the patterns of predation by wild carnivores and their proportion of domestic livestock lifted. Of 187 cases reported in the Survey, goats & sheep were the most frequent among the kills (51 %) followed by young animals (Figure 1). Amongst the wild predators, Tibetan Wolf was involved in the highest number of depredation cases (57 %), followed by Red Fox and Snow Leopard (Figure 2). This is a significant finding as Snow Leopard has been responsible for only 10 % of the cases, contrary to the wide belief that they cause enormous damage. Interestingly, Chundawat et al. (1994) also estimated that livestock formed only c. 14.8 % in Snow Leopard food in Hemis National Park, Ladakh.

FIGURE 1. Frequency of different livestock in depredation cases reported from Zaskar in 1999 (n = 187)

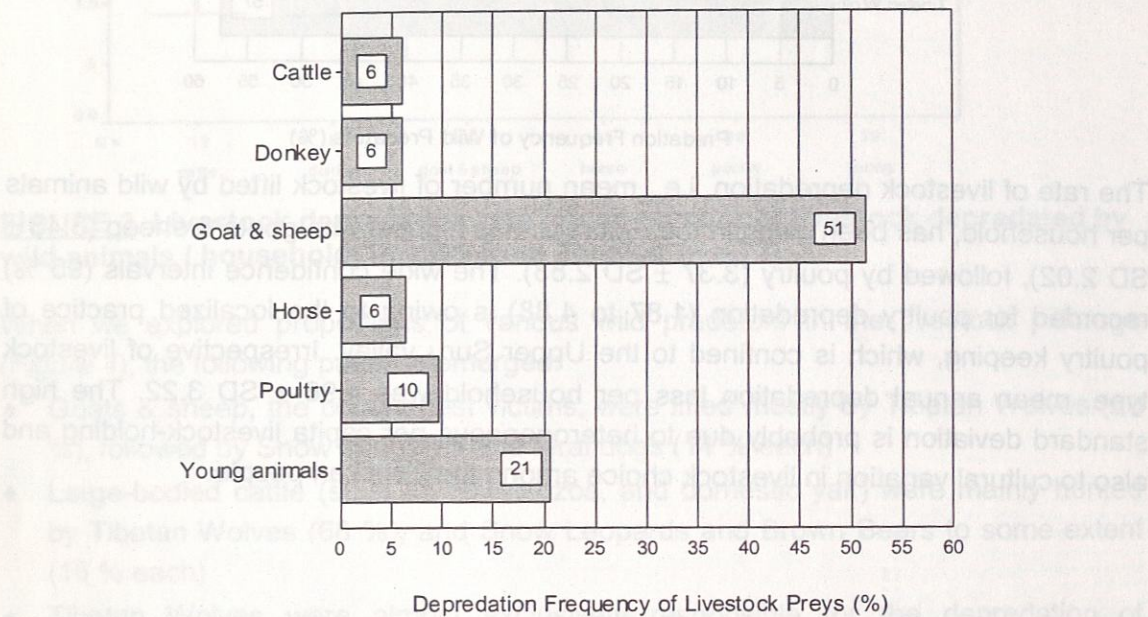
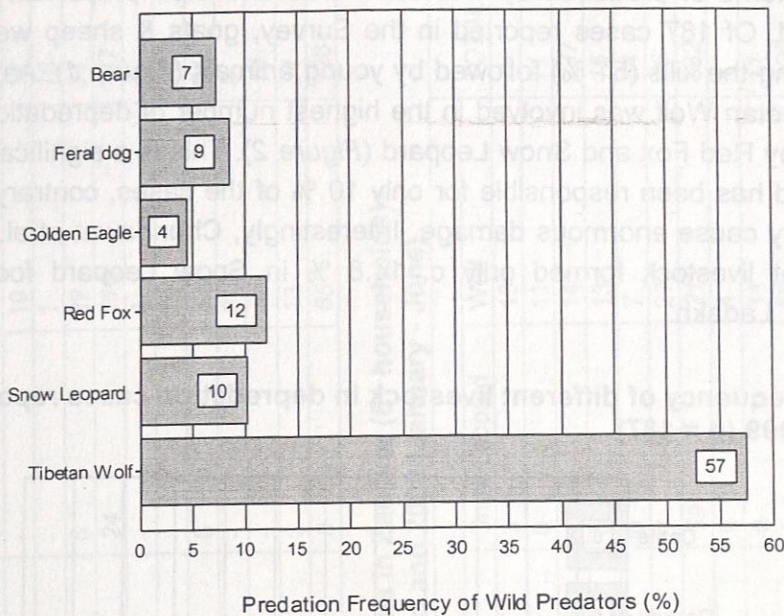


FIGURE 2. Frequency of different wild predators involved in depredation cases reported from Zanskar in 1999 (n = 187)



The rate of livestock depredation, i.e., mean number of livestock lifted by wild animals per household, has been given in the *Figure 3*. It is highest with goats & sheep ($3.43 \pm \text{SD } 2.02$), followed by poultry ($3.37 \pm \text{SD } 2.83$). The wide confidence intervals (95 %) recorded for poultry depredation (1.87 to 4.88) is owing to the localized practice of poultry keeping, which is confined to the Upper Suru valley. Irrespective of livestock type, mean annual depredation loss per household was $4.96 \pm \text{SD } 3.22$. The high standard deviation is probably due to heterogeneous per capita livestock-holding and also to cultural variation in livestock choice among the Zanskari people.

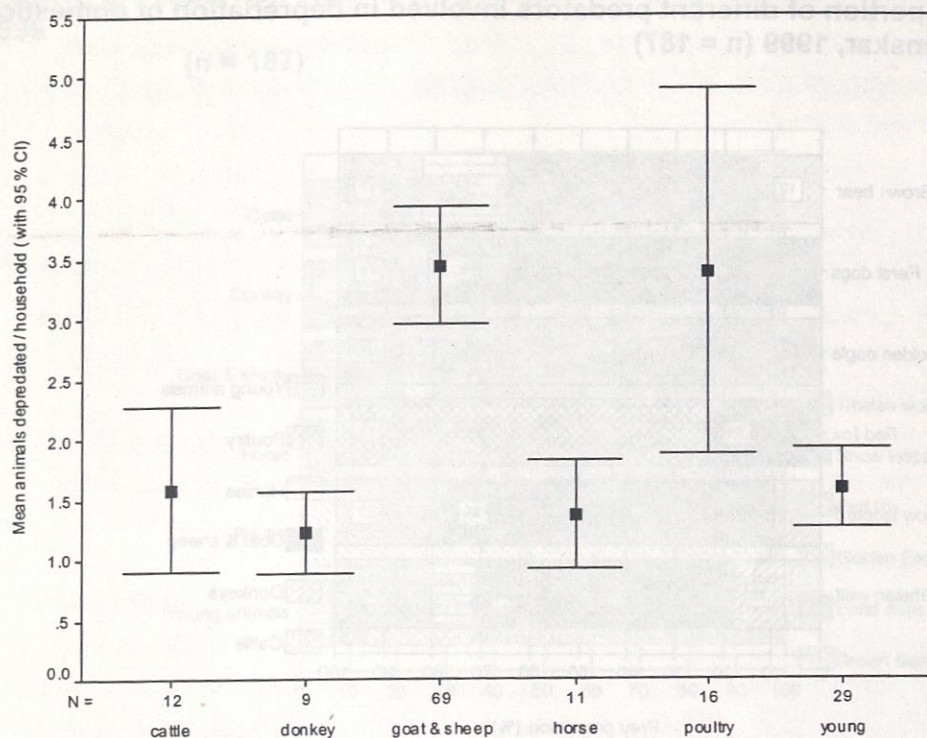
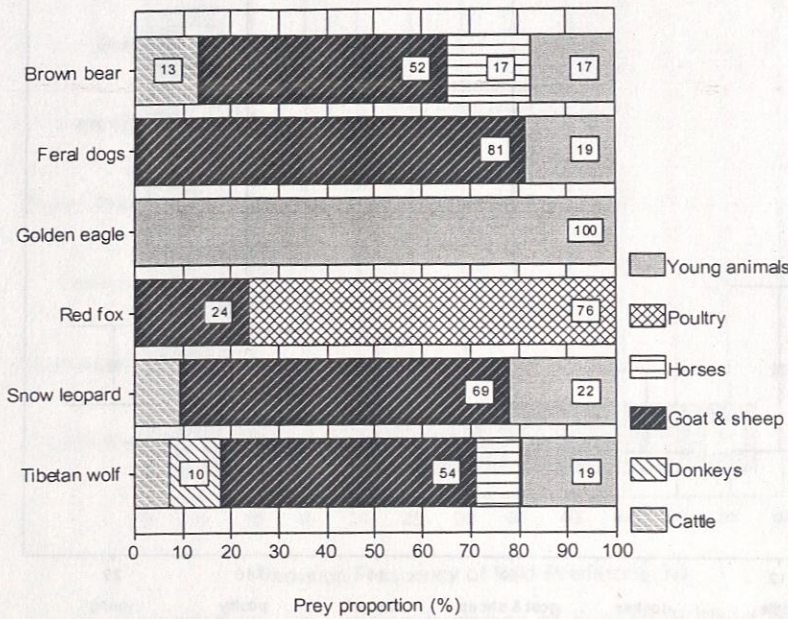


FIGURE 3. Livestock depredation rate (mean number of livestock depredated by wild animals / household) in 1999 from Zanskar (n = 77)

When we explored proportions of various wild predators in the livestock pilferage (Figure 4), the following patterns emerged:

- ◆ Goats & sheep, the commonest victims, were lifted mostly by Tibetan Wolves (60 %), followed by Snow Leopards and feral dogs (14 % each)
- ◆ Large-bodied cattle (such as cows, dzos, and domestic yak) were mainly hunted by Tibetan Wolves (68 %), and Snow Leopards and Brown Bears to some extent (16 % each)
- ◆ Tibetan Wolves were almost exclusively responsible for the depredation of donkeys and horses, while Brown Bears also took a toll on horses in Zanskar valley
- ◆ Young animals (like calves, foals, and lambs) were lifted largely by Tibetan Wolves (54 %) and Golden Eagles (22 %), and
- ◆ Poultry (in Upper Suru valley) were depredated almost solely by Red Foxes (97 %).

FIGURE 4. Proportion of different predators involved in depredation of domestic livestock in Zanskar, 1999 (n = 187)



Livestock-Prey Choice by Wild Carnivores

Alternately, the livestock-prey choice of wild animals could be explored by studying the proportion of various livestock in their prey profile (*Figure 5*).

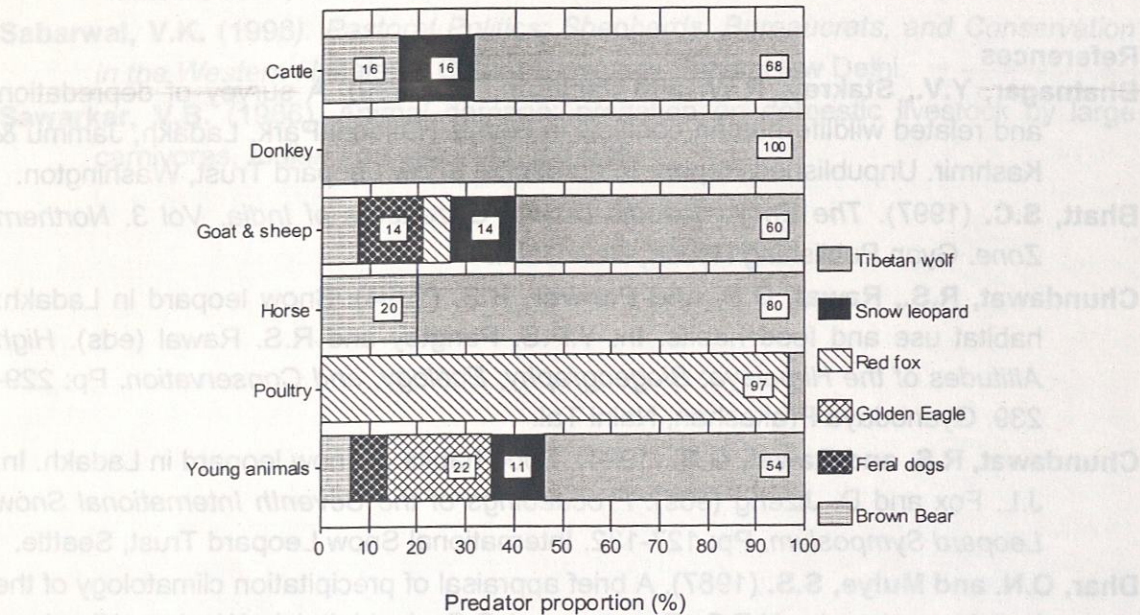
Tibetan Wolves, the major livestock-lifters in Zanskar, had the most eclectic choice of prey; they were recorded to have killed all the types of domestic animals, though in varying proportions. Their chief preys would include goats & sheep (54 %), followed by young animals (19 %) and donkeys (10 %).

- ◆ Goats & sheep (69 %) followed by calves (22 %) and cattle (9%), figured prominently among the *livestock-prey* of Snow Leopards. In another study at Hemis National Park, Ladakh (Chundawat et al., 1994), goats and sheep were found to constitute ca. 84 % of the total livestock taken by Snow Leopards.
- ◆ Though Brown Bears were known to primarily kill goats & sheep (52 %), they also showed a remarkable proclivity to take on large-bodied livestock such as horses (17 %) and domestic cattle (13 %).
- ◆ Red Foxes were unique among the carnivores in the sense that they predominantly took to poultry (76 %) and to some extent goats & sheep (34 %).
- ◆ Golden Eagles, the only avian predator known to cause damage to domestic animals, preyed exclusively on young stock.

We calculated Pearson's Chi-square statistic to test if the livestock-prey choice of wild predators was random. The results clearly showed that the choices were not random ($\chi^2 = 198.21$, $p < 0.001$), pointing to a depredation pattern probably constrained by allometric body-size ratio between predator and prey, and also by life-history traits.

FIGURE 5. Proportion of different livestock lifted by wild carnivores in Zanskar, 1999

(n = 187)



10.6 Conclusion

The management issue of livestock depredation by wild animals requires adoption of area-specific strategies based on a sound study of socio-economic factors involved. A major constraint in developing such programme in India is the fact that some of the wild carnivores identified as potential depredators are listed in Schedule-I of the Wildlife (Protection) Act, 1972 (Sawarkar, 1986). This impunity understandably comes in the way of considering the option of partial removal of identified packs or individuals of wild predators. In this context, the compensation policy of the government has also to be reviewed. The insurance sector should be opened up towards these vulnerable areas as a guard against economic losses through livestock damage.

In this regard, several studies in the past have identified the problem areas and suggested various, innovative measures to mitigate this conservation issue (e.g., Kharel, 1997; Mishra, 1997; Bhatnagar et al., 1999; Hussain, 2000; Jackson, 2000;). Most of these conservation action plans emphasize local community participation in their programmes. For example, schemes evolved by The Mountain Institute and the International Snow Leopard Trust involve APPA (Appreciation Participatory Planning and Action) and PRA (Participatory Rural Appraisal) techniques (Jackson, 2000). These participatory schemes aim at reduction of economic losses, incurred through livestock depredation, by increasing per capita village income, and by building community self-reliance for resource management and income generation. Such innovative action plans have to be implemented by the government functionaries, particularly around the problem areas.

More surveys with focussed objectives need to be taken up to build a sound knowledge base. In particular, economic surveys must be conducted along with biodiversity assessment trials in Zaskar to compute the economic costs of livestock depredation by wild animals.

References

- Bhatnagar, Y.V., Stakrey, R.W. and Jackson, R.** (1999). A survey of depredation and related wildlife-human conflicts in Hemis National Park, Ladakh, Jammu & Kashmir. Unpublished Report. International Snow Leopard Trust, Washington.
- Bhatt, S.C.** (1997). *The Encyclopaedic District Gazetteers of India. Vol 3. Northern Zone.* Gyan Publishing House, New Delhi.
- Chundawat, R.S., Rawat, G.S. and Panwar, H.S.** (1994). Snow leopard in Ladakh: habitat use and food habits. In: Y.P.S. Pangtey and R.S. Rawal (eds). *High Altitudes of the Himalaya: Biogeography, Ecology, and Conservation.* Pp: 229-239. Gyanodaya Prakashan, Naini Tal.
- Chundawat, R.S. and Rawat, G.S.** (1994). Food habits of snow leopard in Ladakh. In: J.L. Fox and D. Jizeng (eds). *Proceedings of the Seventh International Snow Leopard Symposium.* Pp: 127-132. International Snow Leopard Trust, Seattle.
- Dhar, O.N. and Mulye, S.S.** (1987). A brief appraisal of precipitation climatology of the Ladakh region. In: Y.P.S. Pangtey and S.C. Joshi (eds). *Western Himalaya. Vol. I Environment.* Pp: 87-98. Gyanodaya Prakashan, Naini Tal.
- Fox, J.L., Nurbu, C., Bhatt, S. and Chandola, A.** (1994). Wildlife conservation and land-use changes in the Trans-Himalayan region of Ladakh. *Mountain Research and Development*, 14:39-60.
- Hussain, S.** (2000). Protecting the snow leopard and enhancing farmers' livelihoods. *Mountain Research and Development*, 20:226-231.
- Jackson, R.** (2000). Managing people-wildlife conflict in alpine pastures in the Himalayas. In: C. Richards, K. Basnet, J.P. Sah, and Y. Raut (eds). *Grassland Ecology and Management in Protected Areas of Nepal.* Vol. III Technical and Status Papers on Grasslands of Mountain Protected Areas. Proceedings of a Workshop held at Royal Bardia National Park, Nepal, March 15 – 19, 1999, organized by Department of National Parks & Wildlife Conservation - Nepal, ICIMOD – Kathmandu, WWF-Nepal. Pp: 98-118.
- Jina, P.S.** (1995). *High Pasturelands of Ladakh Himalaya.* Indus Pub. Co., New Delhi.
- Jina, P.S.** (1996). *Ladakh: The Land and the People.* Indus Publishing Company, New Delhi.
- Kharel, F.R.** (1997). Agricultural crop and livestock depredation by wildlife in Langtang National Park, Nepal. *Mountain Research and Development*, 17:127-134.
- Kothari, A., Pande, P., Singh, S. and Variava, D.** (1989). *Management of National Parks and Wildlife Sanctuaries in India: A Status Report.* Indian Institute of Public Administration, New Delhi.
- Mishra, C.** (1997). Livestock depredation by large carnivores in the Indian Trans-Himalaya: conflict perceptions and conservation prospects. *Environmental Conservation*, 24:338-343.

Appendix 1

List of villages, their localities and number of households covered by the Survey

S. No.	VILLAGE	LOCALITY	No. OF HOUSEHOLDS INTERVIEWED
1	Hambri	Suru Valley	4
2	Kartsekar	Suru Valley	5
3	Khandi	Suru Valley	5
4	La Lung	Suru Valley	5
5	Minjigaon	Suru Valley	4
6	Panikhar	Suru Valley	5
7	Prentee	Suru Valley	3
8	Sankoo	Suru Valley	5
9	T.T.Chumic	Suru Valley	5
10	Tasgam	Suru Valley	10
11	Chibra	Zanskar Valley	5
12	Kumik	Zanskar Valley	5
13	Manda	Zanskar Valley	5
14	Padum	Zanskar Valley	5
15	Rangdom	Zanskar Valley	5
16	Sani	Zanskar Valley	5

Chapter 11

Management Planning for Trans-Himalayan Protected Areas

by V.B. Mathur

11.1 Background

The conservation of biodiversity requires competent management of the components viz., species, habitat, ecosystems processes and the intrinsic and extrinsic factors which influence the resource utilization and management. The increasing pressure on the natural resources has made the task of resource conservation a very challenging one. The process through which these challenges have to be addressed is the 'Integrated Management Planning Process' the outcome of which is a 'Management Plan'. Thus, a 'Management Plan' is a document, prepared by a management planning process, which sets out the values and objectives for a Protected Area. A Management Plan is a valuable tool for identifying management needs, setting priorities and organizing the approach to the future. A Management Plan is also a communication tool to gain both the understanding as well as support from the local communities and the various agencies which are involved in its management. The conceptual underpinnings of the PA management planning process currently in operation in the country are largely based on the planning document 'A Manual for Planning Wildlife Management in Protected Areas and Managed' by Sawarkar, 1995. This Management Planning manual provides a comprehensive account of conservation philosophy, field realities, planning rationale and process. The Trans-Himalaya is a unique area from the standpoint of biodiversity conservation and the existing network of PAs in this region has the mandate to conserve the conservation values on one hand and also to meet the resource dependance of the local communities to a large measure. Like many other regions of the country, the PAs in the Trans-Himalaya also do not have scientifically developed Management Plans and thus under this Ladakh initiative an attempt is being made to facilitate the management planning process in some PAs of the region. With this background, a Management Planning Workshop was organized in Leh during 27-29 August, 2000.

11.2 Workshop Objectives

- ◆ To discuss pertinent conservation issues relating to wildlife conservation in the Indian Trans-Himalaya
- ◆ To develop guidelines for formulating Management Plans for the PAs in the Trans-Himalaya, with special reference to areas with the endangered snow leopard
- ◆ To initiate the preparation of Management Plan for one PA in Ladakh
- ◆ To encourage the Government to recognize the need for such plans for PAs with the snow leopard and emphasize to the State and Central Governments the need for preparation of PA Management Plans and provisioning of special funds towards implementation of these plans.

11.3 Workshop Programme

The workshop programme included discussions on the (i) Existing and Proposed PA Network in the Trans-Himalayas and its implications for conservation; (ii) Management Plans – utility, process and implementation; (iii) Conservation Issues in PAs of Ladakh; (iv) Livestock Grazing and (v) People's Participation. Besides this, panel discussions on (i) Conservation Issues and Strategies; (ii) Legal Framework for Conservation (iii) Integrating PA management in the Regional Context and (v) International Funding for Conservation were also organized. The detailed programme is given in **Annexure 11.1**.

11.4 Workshop Participants

Eighteen resource persons & participants from WII, collaborating agencies, J&K Wildlife Department, Local Government and NGOs attended the workshop. The list of the participants is given in Annexure 11.2. The workshop was inaugurated by Mr. Thupthen Tsewang, Chairman, Ladakh Autonomous Hill Development Council.

11.5 Management Planning Process for Hemis National Park

In order to 'walk through' the management planning process it was agreed to work out (a) Conservation Values; (b) Objectives of Management and (c) Management Objectives – Problem Matrix for the Hemis National Park. Based on the brainstorming session, consensus was achieved on the following:

11.5.1 Conservation Values of Hemis National Park

Values	Description
Global	Harbours the rare, elusive and endangered snow leopard Provides habitat for four species of wild caprini World famous trekking site
National	Representative area of Biogeographic Province – 01A Provides habitat for a range of rare/endangered species of plants and animals Unique cultural values
State	Largest National Park having high altitudinal variation Harbours the only population of the endemic sub-species, Ladakh urial inside a NP
Local	Provides employment opportunities and enhances income Provides forage to domestic livestock Provides sustenance to human population

11.5.2 Objectives of Management of Hemis National Park

1. To maintain a regionally significant population of snow leopard
2. To maintain a regionally significant population of four species of wild caprini
3. To mitigate human-wildlife conflicts
4. To provide opportunities for conservation-compatible tourism, nature interpretation and conservation education
5. To provide local stewardship and responsibility for protection of wildlife resources to local communities
6. To facilitate research and monitoring of biodiversity resources

11.5.3

Management Objectives – Problem Matrix for Hemis National Park

Sr. No	Problem	Objectives						Hindrance score	Rank
		01	02	03	04	05	06		
1	Lack of protection infrastructure	O ³ xH ₃	O ³ xH ₃	O ² x H ₃	O ² x H ₃	O ² x H ₂	O ² x H ₂	38	I
2	Lack of coordination amongst line/district agencies	O ³ xH ₃	O ³ xH ₂	O ² x H ₃	O ² x H ₃	O ² x H ₃	O ² xH ₂	37	II
3	Lack of awareness	O ³ xH ₃	O ³ xH ₂	O ² x H ₃	O ² x H ₃	O ² x H ₃	O ² xH ₁	35	III
4	Overgrazing	O ³ xH ₃	O ³ xH ₃	O ² x H ₃	O ² xH ₁	O ² xH ₁	O ² xH ₁	30	IV
5	Livestock losses	O ³ xH ₃	O ³ xH ₁	O ² x H ₃	O ² xH ₂	O ² xH ₂	O ² xH ₁	28	V
6	Crop damage	O ³ xH ₁	O ³ xH ₁	O ² x H ₃	O ² xH ₁	O ² x H ₃	O ² xH ₁	22	VI
7	Unregulated tourism	O ³ xH ₂	O ³ xH ₂	O ² xH ₁	O ² xH ₁	O ² xH ₂	O ² xH ₁	22	VI
		54	42	38	28	32	18		

N.B.: O³=High Priority; O²=Medium Priority; O¹=Low Priority

H₃=High Hindrance, H₂=Medium Hindrance, H₁=Low Hindrance

'Hindrance' is the measure of constraints faced in achieving the objective. A high hindrance score indicates a high degree of difficulty and vice-versa.

To develop the Management Objectives – Problem Matrix, the management objectives were first prioritized in three categories viz., O³=High Priority; O²=Medium Priority; O¹=Low Priority. Similarly, the problems were also classified into 3 hindrance categories viz., H₃=High Hindrance, H₂=Medium Hindrance, H₁=Low Hindrance. Hindrance score is the product of the objective priority and the Hindrance category. A high hinderance score indicates a high degree of difficulty in achieving the objectives.

Based on the Management Objective – Problem Matrix, it can be inferred that 'lack of protection infrastructure' is the most significant problem facing the management of Hemis National Park. This is mainly due to extremely low investment in both manpower and financial resources required for managing the resource. Similarly, the objective of management of 'maintaining a regionally significant population of snow leopard' has the highest hindrance score. Apart of lack of protection infrastructure, the almost absence of coordination amongst line/district agencies and low conservation awareness level also seriously impair the ability of the PA management to conserve a viable snow leopard population. Overgrazing and conflicts with wildlife are also significant issues that need to be addressed, especially to ensure long-term co-existence between park and people.

11.6 Workshop Recommendations

- ◆ Recognizing the need to conserve Snow Leopard and its habitat along with its associated prey species it is recommended that Project Snow Leopard, formulated earlier by the Government of India, should be initiated, for which adequate funds should also be provided by the Central & State Governments.
- ◆ Acknowledging that a good management plan is a pre-requisite for scientific management, the process for preparation of management plans for the PAs in the Trans-Himalayan areas should be initiated by the State Government in technical collaboration with the Wildlife Institute of India.

- ♦ Realizing that the Human-Livestock conflict is a key area of concern, participatory planning procedures based on good ecological practices being implemented in Snow Leopard range countries should be adopted to mitigate this conflict.
- ♦ Considering the need for integrating the PA management plan within the regional planning process the wildlife conservation and management matters should be taken up at the appropriate level with the Ladakh Autonomous Hill Development Council.

11.7 The Way Forwards

The establishment of a network of PAs to maintain the integrity of an area and for conservation of biodiversity is a globally accepted practice. However, equally important consideration is to ensure the 'management effectiveness' of the PAs. Unless this happens, most PAs will remain 'paper PAs' much divorced from the ground realities. The first step in building 'management effectiveness' is to initiate the development of 'Integrated Protected Area Management Plans (IPAMPs)' through a participatory process involving all stakeholders including the local communities. These IPAMPs should have a 'conservation-oriented development' focus. A systematic capacity building effort is required for developing IPAMPs, for which the WII under its Ladakh initiative and other programmes as well would be able to provide valuable support. Since initiatives to conserve snow leopard populations have to involve several Indian States it is necessary to re-vitalize the 'Project Snow Leopard'. To facilitate this, the WII plans to organize meetings and workshops under its Ladakh initiative in the year 2001 and bring together the Central and State Government representatives to develop and implement conservation action at the field level.

**MANAGEMENT PLANNING WORKSHOP FOR THE TRANS-HIMALAYAN
PROTECTED AREAS
Workshop Programme**

Date	Time	Topic	Speaker
25 Aug	Inaugural session		
	1000-1100	Welcome from WII Inauguration by Chairman, Ladakh Autonomous Hill Development Council Introductory speeches by Director, WII Chief Wildlife Warden/Representative	YVB
		Introduction to workshop	VBM
	1100-1130	Protected area network in the Indian Trans-Himalaya	VBM
	1130-1200	Tea Break	
	1200-1230	Wildlife of Ladakh	YVB
	Conservation issues		
	1230-1300	Conservation issues in the PAs of Ladakh	RZ
	1300-1400	Lunch	
	1400-1430	Livestock grazing and impacts on the Trans-Himalayan environment	CM
	1430-1530	People-Wildlife conflicts in the Trans-Himalaya	RJ
26 Aug	Administrative and legal issues		
	1000-1030	Views of the Chief Wildlife Warden	NK
	1030-1100	Views from the Wildlife Warden, Leh	RZ
	1100-1200	Management plans – utility, process and implementation	VBS
	1200-1230	Community participation – tools and examples	RJ
	1230-1330	Management Planning exercise for Hemis NP	VBS/VBM
	1330-1430	Lunch	
	1430-1530	Management Planning exercise for Hemis NP	VBS/VBM
27 Aug	Initiatives and future direction		
	1030-1130	Panel Discussion on legal framework	SKM, VBS, NK
	1130-1230	Panel Discussion on possibilities of international funding	DH, SKM, RJ, VBM
	1230-1330	Lunch	
	1330-1530	Integrating Protected Area Management in the regional context	SKM/VBS/VBM /NK/RZ
28 Aug	Field trip to Hemis NP for meeting with villagers residing in the park		
	0800-1030	Reach Rumchum	
	1030-1230	Discussion with village stake holders	VBM/VBS
	1230-1430	Return to Leh	
29 Aug	1000-1100	Outputs of the Management Planning process Workshop recommendations	VBM/VBS/NK/ RZ
	1100-1130	Tea	
	1130-1300	Closing session Closing remarks	SKM, NK, RZ, NGO representatives /DH, RJ

SKM: SK Mukherjee
VBS: VB Sawarkar
VBM: VB Mathur

NK: Nasir Kichloo
RZ: Rauf Zargar
CM: C. Mishra

YVB: YV Bhatnagar
DH: Don Hunter
RJ: Rodney Jackson

List of Participants

Shri Thupten Tsewang, Chairman,
Ladakh Autonomous Hill Development
Council

Shri S.K. Mukherjee, Director, Wildlife
Institute of India

Shri V.B. Sawarkar, Additional
Director, Wildlife Institute of India

Dr. V.B. Mathur, Scientist – SG (T)

Shri Angchuk, SDM, Leh

Shri Rajeev Kumar Tewari, DFO, Leh

Shri Takpa, IFS, Employment Officer,
Leh

Dr. Yash Veer Bhatnagar, Scientist-
SD, Wildlife Institute of India

Dr. B.S. Adhikari, Scientist-SD,
Wildlife Institute of India

Shri Nasir Kitchloo, Reg. Wildlife
Warden, J&K

Shri Rauf Zargar, Wildlife Warden, Leh

Shri Abdul Rauf, Range Officer,
Department of Wildlife Protection
(DWP), J&K

Shri Angchuk, RO, DWP

Shri Angchuk, Forester, DWP

Shri T. Semphel, Director, Leh
Nutrition Project

Shri Senam Wangchuk, Director,
SECMOL

Dr. Rodney Jackson, Snow Leopard
Conservancy

Shri Rinchen Wangchuk, Project
Field Associate, ISLT

Shri Don O. Hunter, USGS

Representatives from the Ladakh Tourism Department, Animal Husbandary
Department and Ladakh Ecological Development Group also participated in some
sessions.