SNOW LEOPARD
SURVEY AND CONSERVATION HANDBOOK

International Snow Leopard Trust
U.S. Geological Survey
Biological Resources Division

The authors recommend the following citation for this document:

Jackson, Rodney and Hunter, Don O. 1996 (Second Edition). Snow Leopard Survey and Conservation Handbook. International Snow Leopard Trust, Seattle, Washington and U.S. Geological Survey, Fort Collins Science Center, Colorado. 154 pages + appendices.

This document consists of three parts:
Part I: Introduction (Objectives & Background). 4.4 MB (*SL_Survey_Cons_Handbook_Part_1.pdf*)
Part II: Snow Leopard Survey Methods. 2.2 MB (*SL_Survey_Cons_Handbook_Part_2.pdf*)
Part III: Prey Species, Habitat Assessment, Conservation and Appendices. 1.8 MB (*SL_Survey_Cons_Handbook_Part_3..pdf*)

SNOW LEOPARD SURVEY AND CONSERVATION HANDBOOK

Rodney Jackson, Ph.D.
International Snow Leopard Trust
4649 Sunnyside Avenue North
Seattle, Washington 98103 USA

Don O. Hunter
Biological Resources Division
Midcontinent Ecological Science Center
4512 McMurry Avenue
Fort Collins, Colorado 80525-3400 USA

Second Edition
November 1996

Cover Photo: Art Wolfe and Helen Freeman

Acknowledgments

Many persons and organizations contributed to this handbook. Funding was provided by the International Snow Leopard Trust (ISLT) through a grant from the Leonard X. Bosack and Bette M. Kruger Charitable Foundation of Redmond, Washington. Support was also provided by the Messerli Foundation, Switzerland, Mill Pond Press, Florida and the membership of ISLT. Special appreciation is due to the Board of Directors, a strong and active force behind ISLT's programs.

Thanks to Dave Ferguson, Larry Mason, and Steve Kohl of the U.S. Fish and Wildlife Service (Office of International Affairs) for providing hardware, technical, and logistical support. The authors and ISLT are especially grateful to Rey C. Stendell, Biological Resources Division, Midcontinent Ecological Science Center, Fort Collins, Colorado, for an especially fruitful partnership in all phases of this project.

Helen Freeman, Founder of ISLT, was the catalyst for the Snow Leopard Information Management System (SLIMS) and played a major role in its development as part of Project Snow Leopard. The standard field techniques evolved from research in Nepal conducted by Rodney Jackson, Gary Ahlborn, and Karan B. Shah. Vital in–country support for the establishment of SLIMS has been forthcoming from the following conservation leaders: in China, Professors Li Bosheng, Wang Zhongyi, Wang Sung, and Tan Bangjie; in Pakistan, Ashiq Ahmad and Dawood Ghuznavi, World Wild Fund for Nature–Pakistan, along with Mumtaz Malik, Conservator of Wildlife, Northwest Frontier Province; in India, Hemandra S. Panwar and Gopal Rawat, and Raghu Chundawat, Wildlife Institute of India; and in Mongolia, Jachin Tserendeleg, Mongolian Association for the Conservation of Nature and the Environment.

Invaluable input was provided by field researchers working in the countries hosting wild snow leopards and their prey. In India, Raghu Chundawat, Joseph L. Fox, and David Mallon; in China, Lu Xuedong, Duan Xu, and Chen Yun; in Nepal, Madan Oli; in Russia, Eugene Koshkarev; and in Pakistan, Saeed–Uz–Zaman. George B. Schaller and Thomas M. McCarthy tested the methodology in Mongolia and offered helpful ideas for its improvement. Richard B. Harris and Daniel Miller offered advice on ungulate census techniques. Additional input was provided by Michael Green of the International Union for Conservation of Nature and Natural Resources (IUCN) World Monitoring Centre, Cambridge; Paul Joslin formerly of Wolf Haven; Peter Jackson, Chairman of the Cat Group, Species Survival Commission, IUCN. Editing and production was done by Darla Hillard, Judy Scherpelz, Dora Medellin, and Rebecca Lange, and map/GIS support from Chris Emmerich.

Comments on this handbook should be addressed to:

International Snow Leopard Trust
4649 Sunnyside Avenue North
Seattle, WA 98103
Phone (206) 632-3967; Fax (206) 632-3967
E-mail: tmccarthy@snowleopard.org
Authors e-mail: rodjackson@mountain.org or don_o_hunter@usgs.gov

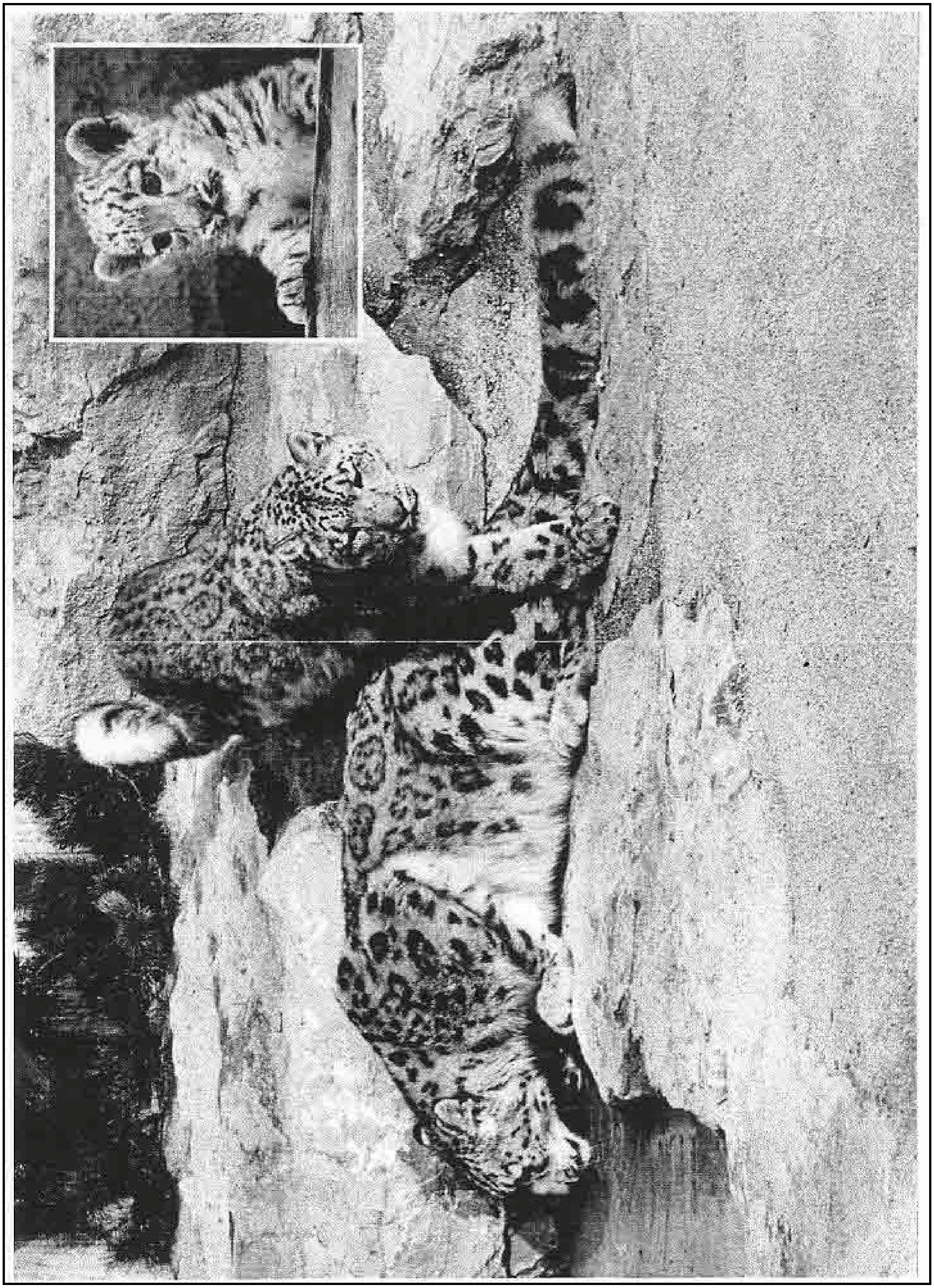
Table of Contents

Table of Contents. Continued.

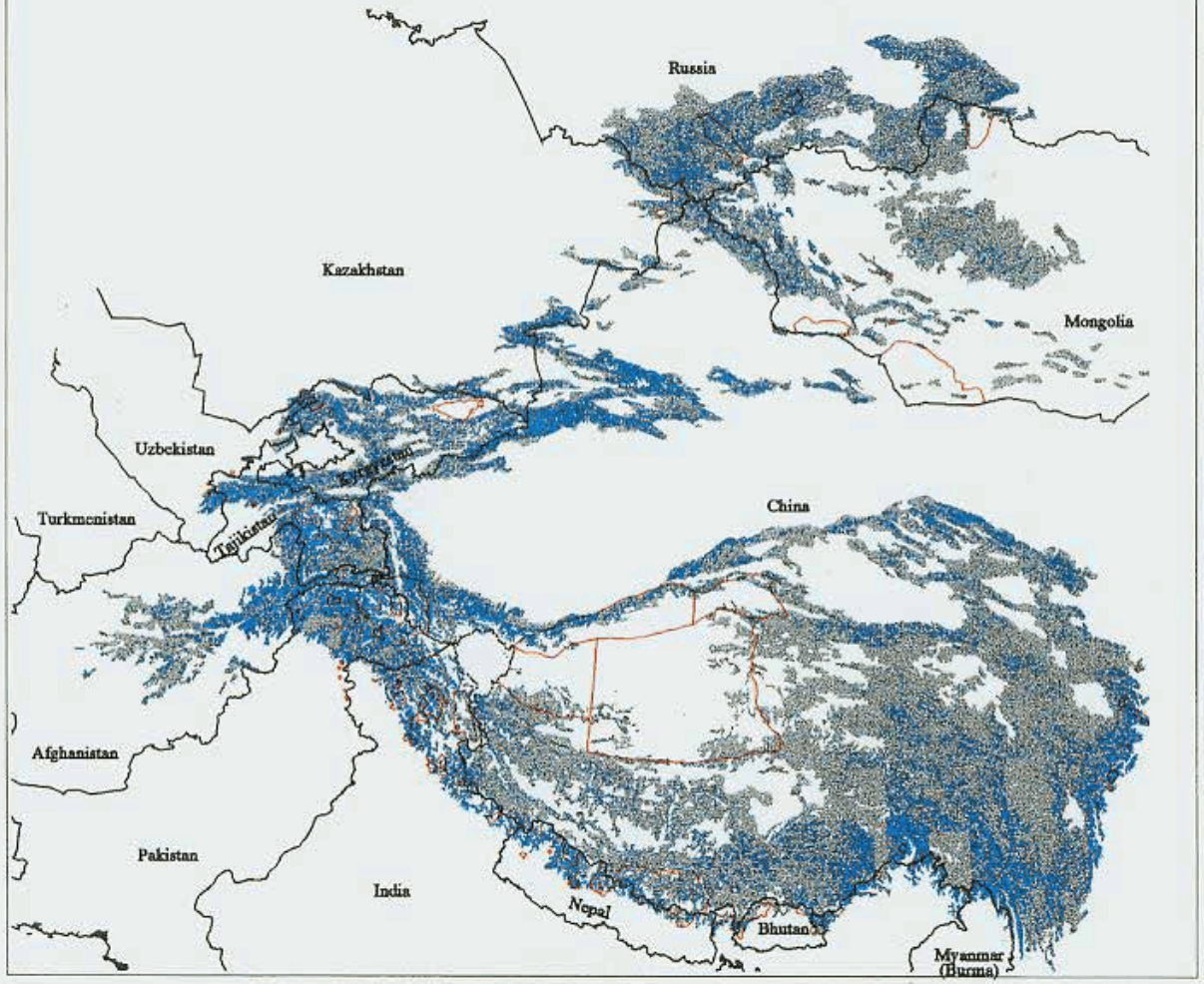
Table of Contents. Concluded.

List of Figures

List of Figures. Concluded.



Snow Leopard *(Uncia uncia)* Habitat



Legend

- Good Snow Leopard Habitat (> 30 degree slope and outside human disturbance buffers)
- Fair Snow Leopard Habitat (unknown slope or <= 30 degree slope or inside human disturbance buffers)
- Existing Reserves

Area Report

Total Potential Habitat	3,024,728 sq. km
Total Good Habitat	549,706 sq. km
Total Fair Habitat	2,475,022 sq. km
Total Protected Potential Habitat	181,547 sq. km
Percent of Potential Habitat Protected	6

Produced by the National Biological Service, Midcontinent Ecological Science Center Development Team, Ft. Collins, CO. in Cooperation With the International Snow Leopard Trust and the Leonard X. Bosack & Bette M. Kruger Charitable Foundation, Seattle, Wa.; and the U.S. Fish and Wildlife Service.
http://dexter.mesc.nbs.gov

Chapter One – Project Snow Leopard

Introduction

The objectives of the handbook are to provide standard procedures for conducting snow leopard status and distribution surveys; suggest uniform methods for assessing the status and relative abundance of large prey species (ungulates such as blue sheep, argali, markhor, Himalayan tahr, urial, ibex, red deer, and roe deer); offer guidance in evaluating habitat quality and identifying the major environmental factors affecting species welfare; and provide standard forms for reporting the results of these field surveys, and a process for feeding information developed by the International Snow Leopard Trust (ISLT) into Snow Leopard Information Management System (SLIMS).

The snow leopard (*Uncia uncia*) (formerly known as *Panthera uncia*) is a carnivore of the high mountains of central Asia, noted for its rarity and as an indicator of the ecological health of high altitude ecosystems. These ecosystems support a unique flora and fauna, but increasing human encroachment threatens biodiversity throughout the region, and conservation efforts are hampered by rugged terrain and a patchwork of ecosystems among countries with contentious borders and different political ideologies. Most countries of central Asia are striving to establish more reserves for endangered species or unique biogeographic zones. Project Snow Leopard (PSL), spearheaded by the ISLT, is a multinational program to help conserve central Asian biodiversity, especially high altitude ecosystems. Specifically, PSL's goals are to promote the establishment of reserves and linking corridors, protect prey species and key mountain habitats, minimize the poaching and trading of snow leopards or their body parts, and to address local people's concerns relating to the depredation of livestock by snow leopards. In cooperation with international conservation organizations and the 13 countries in central Asia with snow leopard, PSL seeks to strengthen the capability of local conservation institutions. PSL will become a multinational information network on reserves when adopted and implemented on a country–by–country basis, leading to improved management and a more meaningful picture of biodiversity in central Asia (Box 1–1).

The snow leopard, classified as an endangered species by the World Conservation Union (also known as IUCN, the International Union for Conservation of Nature and Natural Resources), and the U.S. Endangered Species Act (1973), is disappearing from many parts of its formerly vast range. Its historic range (an area in excess of 3.0 million km^2) has become increasingly fragmented, and its populations have declined significantly because of widespread poaching; a profitable trade in its pelt, bones, and other body parts; retribution from pastoralists whose livestock have been killed; and a rapidly dwindling natural prey base. The decline in snow leopard numbers coincides with increasing population and ecological degradation in the mountain environment.

Box 1-1. The snow leopard as an indicator species.

The snow leopard serves as an indicator species for Asia's high mountain ecosystems, as it resides at the top of the food chain, requires large home ranges, moves over vast areas and flourishes under pristine conditions. It is also a "flagship" species around which people rally support for far–reaching conservation initiatives. The snow leopard's endangerment has made it a symbol for international cooperation. Conservation efforts in the high mountains of central Asia are hindered by political instability and large border areas off–limits to scientific study. In addition, this region is perhaps the most inhospitable in the world for scientific studies. By protecting snow leopards, one also protects habitat for a host of other plant and animal species. Where the snow leopard occurs in good number, the environment is considered to be more productive and healthy. Because parks and reserves are generally the primary repository for Asia's remaining mountain biological diversity, governments need to protect them. With steep slopes and shallow soils, high–altitude ecosystems are among the most fragile of the Earth's habitats. Yet, these areas support critical watershed for low–lying valleys and plains, where the nation's human, agricultural, and industrial activities are concentrated.

The mountainous region of central Asia includes portions of 13 countries: China, India, Pakistan, Nepal, Afghanistan, Mongolia, Bhutan, Russia, Kazakhstan, Kyrgystan (Kirghizstan), Tajikistan, Uzbekistan, and Myanmar (Burma). Reserves (including parks, protected areas, and sanctuaries) are established to protect endangered species or unique biogeographic zones – areas that do not conform to political boundaries. The future of the snow leopard and other rare species depends on protecting large blocks of suitable habitat, including border areas (Schaller et al. 1987; Jackson and Ahlborn 1990; Fox 1994; Green 1994; Nowell and Jackson 1996).

Most countries of central Asia are attempting to set aside more reserves for endangered species or unique biogeographic zones. Each country, however, surveys high mountain species and habitat differently, and the criteria for establishing reserves also differ between countries. They exchange little data on reserves and few of the reserves are located along border areas. In addition, conflicts between local people and the authorities counter the effective management of parks and protected areas.

Project Snow Leopard, fashioned after India's Project Tiger, proposes to standardize the methods for gathering data on the snow leopard, its prey, mountain biodiversity, and management of reserves. The International Snow Leopard Trust, the U.S. Fish and Wildlife

Service, and the Biological Resources Division, Midcontinent Ecological Science Center, have developed a computer program [the Snow Leopard Information Management System (SLIMS)] and drafted this handbook, describing how to conduct high mountain surveys and store data in a standard fashion. In joining PSL, each country agrees to share data with ISLT and each other, thus creating a network among the countries of central Asia. ISLT will make these data readily accessible through a standard computer program networked among the countries that share the high mountains of central Asia.

The SLIMS computer program consists of two interconnected databases, a relational form and a text form. Together, they permit rapid comparisons of conditions across the snow leopard's range and provide written summaries of reserves and relevant conservation issues.

Data such as administration, physical features, biological attributes, and human activities will come from scientific literature, questionnaires, maps and unpublished reports, and field surveys that use standard methods presented in this handbook. Products include statistical information and written reports, by reserve or country, which can be exchanged among interested parties. SLIMS has been developed for flexibility and will evolve as it is used in the field.

SLIMS is being used under cooperative agreements among countries with wild snow leopards and the ISLT. Each country will have its own computer system and program to store and manage species, habitat, and conservation information. SLIMS is focused on information related to the snow leopard and its habitat within existing or proposed reserves rather than in its entire range. While each country will be responsible for data within its borders, ISLT will maintain a world–wide system at its headquarters office networked to a specific facility or node in each country. SLIMS will enable comparisons among countries and across all countries comprising the protected area network for snow leopard.

SLIMS is dependent on host country contributors (wardens, forest officers, wildlife biologists, academicians, etc.) to provide baseline information. Results from field surveys made by such contributors will be entered into the SLIMS in–country database. Thus, all field researchers are encouraged to submit their results to the SLIMS in–country facility, which will transmit selected information to ISLT. Results of field surveys will be reported in ISLT's newsletter, *SNOWLINE*, which is widely distributed to researchers in Asia and elsewhere in the world. In–country facilities participating in SLIMS will publish annual snow leopard status reports, as well as special reports drawing on the regularly updated database.

Objectives and Background of this Handbook

Unless consistent methods are used, it is difficult to make comparisons among areas surveyed by different observers, or even among different areas surveyed by the same person. Too often observers fail to report the "where's, why's, and how's" of their surveys, or to indicate

the basis for their prey population estimates. Surveys standardized across countries are needed to assess snow leopard status throughout its range. Field surveys can more significantly contribute to our knowledge of snow leopard and prey species status, distribution, and ecology if comparable techniques are employed, and if observers report their search efforts in a consistent manner.

This handbook provides a standard method, in two levels of effort, for evaluating current status of snow leopard and its major prey. Presence–absence surveys provide an overview of an area, while abundance surveys are intensively focused. The handbook describes how to map snow leopard range, assess habitat conditions, identify snow leopard sign, estimate populations of snow leopard and that of large ungulates, and evaluate key management and conservation issues in the survey area. Survey methods and database use are taught by PSL scientists in workshops indoors and in the field.

Topics addressed here include survey goals and objectives, determining where best to search for sign of animals, which kind of sign is most informative, and how much effort may be required in the field. Ways of distinguishing among snow leopard sign and that of other predators such as wolf and lynx are provided. Ideas and strategies for improving management practices and resolving people–wildlife conflict are introduced. The handbook suggests how observers can report results to facilitate dissemination of findings and recommendations to all parties involved in conservation of the snow leopard and its habitat.

The techniques described in this handbook depend heavily on suggestions and feedback from users. Comments such as whether the methodology descriptions are clear, which techniques work best, and how these methods can be improved, should be sent to ISLT. By supporting SLIMS and standard field techniques, contributors will significantly advance conservation of the snow leopard and its fragile mountain environment. By participating in scientific exchanges, contributors help foster new approaches to resource management that both benefit the people who share the snow leopard's habitat and protect a unique part of the world's rich natural heritage.

Chapter Two – General Ecology of Snow Leopards

Brief Background on Snow Leopards

The snow leopard stands about 60 cm high at the shoulder, with a head to body length of 100 to 130 cm and a long, thick tail three–fourths as long as the body. Females weigh 35 to 40 kg and males 45 to 55 kg. The luxuriant spotted pelage is whitish–gray tinged with yellow and contains dark, open, or otherwise indistinct rosettes and spots. Other adaptations for mountain life include large forepaws, short limbs, well–developed chest muscles, long hair with dense underfur, and the long tail that can be used to keep the animal warm while at rest (see frontispiece illustration). It is generally solitary, although groups of up to six snow leopards have been reported – presumably these groups consist of a female and her nearly independent young, and possibly a male. One to five cubs are born after a gestation period of 93 to 110 days, generally in June or July.

Mating usually occurs between late January and mid–March, a time of intensified social marking. These social markings include scrapes, feces, scent sprays and claw rakings, which are deposited along travel routes used by snow leopards (Box 2–1).

Box 2–1. Social markings of snow leopards.

- Scrapes: Snow leopards scrape or scuff the ground with their hind paws, leaving a distinctive mark consisting of an oblong depression with a pile of earth at one end.
- Feces or scats: Feces are deposited alone or in association with other sign.
- Urine: Snow leopards may urinate on the top of their scrapes.
- Scent–spraying: Both sexes may scent–mark upright rock faces by spraying them with urine.
- Claw–raking: Snow leopards may leave claw marks on tree trunks or rock faces.
- Tracks: Tracks (also called pugmarks or spoor) are left as an imprint of the feet on soft ground but are short–lived.

TWO – SNOW LEOPARD ECOLOGY

Snow leopards are closely associated with the alpine and subalpine ecological zones, preferring broken, rocky terrain with vegetation that is dominated by shrubs or grasses (Figure 2–1). In the Sayan Mountains of Russia and parts of the Tien Shan Range, they are found in open coniferous forest, but they usually avoid dense forest. They generally occur between elevations of 3,000 to 4,500 m, except within their northern range limit where they are found at lower elevations (900 to 2,500 m). Reports suggest that they migrate to lower elevations during winter in northern Pakistan, the Tien Shan Mountains, ranges in Russia, and parts of India, following movements of their primary prey species such as ibex and markhor. Snow leopards prefer steep terrain broken by cliffs, ridges, gullies, and rocky outcrops, although they may traverse relatively gentle country, especially if ridges offer suitable travel routes and shrubs or rock outcrops provide sufficient cover. They show a strong preference for irregular slopes in excess of 40° and well–defined landform edges, such as ridgelines, bluffs and ravines, along which to travel about their home range.

Home range size and shape is not well known. The home range size of five snow leopards in prime habitat in Nepal ranged from 12 to 39 km^2, with substantial overlap between individuals and sexes. Animals usually moved straight line distances of 1 to 1.3 km between consecutive days, but are capable of periodic long–distance movement. Typically, a snow leopard remains within a relatively small area for 7 to 10 days, then shifts its activities to another relatively distant part of its home range. A study in Nepal indicated that 42–60% of home–range use occurred within only 14–23% of the animal's total home area, indicating strong use of core areas, although this use was separated temporally. Core areas were marked significantly more than non–core sites suggesting that social marking plays an important role in spacing individuals. Home ranges overlap in other areas, with ranges of similar size being reported from Ladakh and Mongolia.

The snow leopard is an opportunistic predator capable of killing prey up to three times its own body weight. Its main prey are blue sheep (*Pseudois nayaur*), Asiatic ibex (*Capra ibex sibirica*), argali (*Ovis ammon*) and other wild sheep and goats, along with domestic stock, marmots (*Marmota* spp.), pikas (*Ochotona* spp.), hares (*Lepus* spp.), and gamebirds (snowcocks, *Tetraegallus* and chukar partridge, *Alectoris chukar*) (Figure 2–2). In Russia, Siberian red deer (*Cervus elaphus maral*), roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*), and even reindeer have been taken by snow leopards, while young camels (*Camelus bactrianus*) are occasionally killed in Mongolia.

The range of ibex and blue sheep closely parallels that of the snow leopard. The figure on the frontispiece shows the potential range of the snow leopard based on habitat, which encompasses a total of over 3.0 million km^2. It is not present throughout this area; its core distribution ranges from China in the Gongga Shan Mountains of Sichuan Province, the Qilian Shan of Gansu Province, and the Bayan Har Shan and Anyemaqin ranges of Qinghai Province along the Kunlun Shan, Arjin Shan and through numerous mountain chains on the Tibetan Plateau (Tibet or Xizang Autonomous Region) to the Himalayas of India, Bhutan, and Nepal,

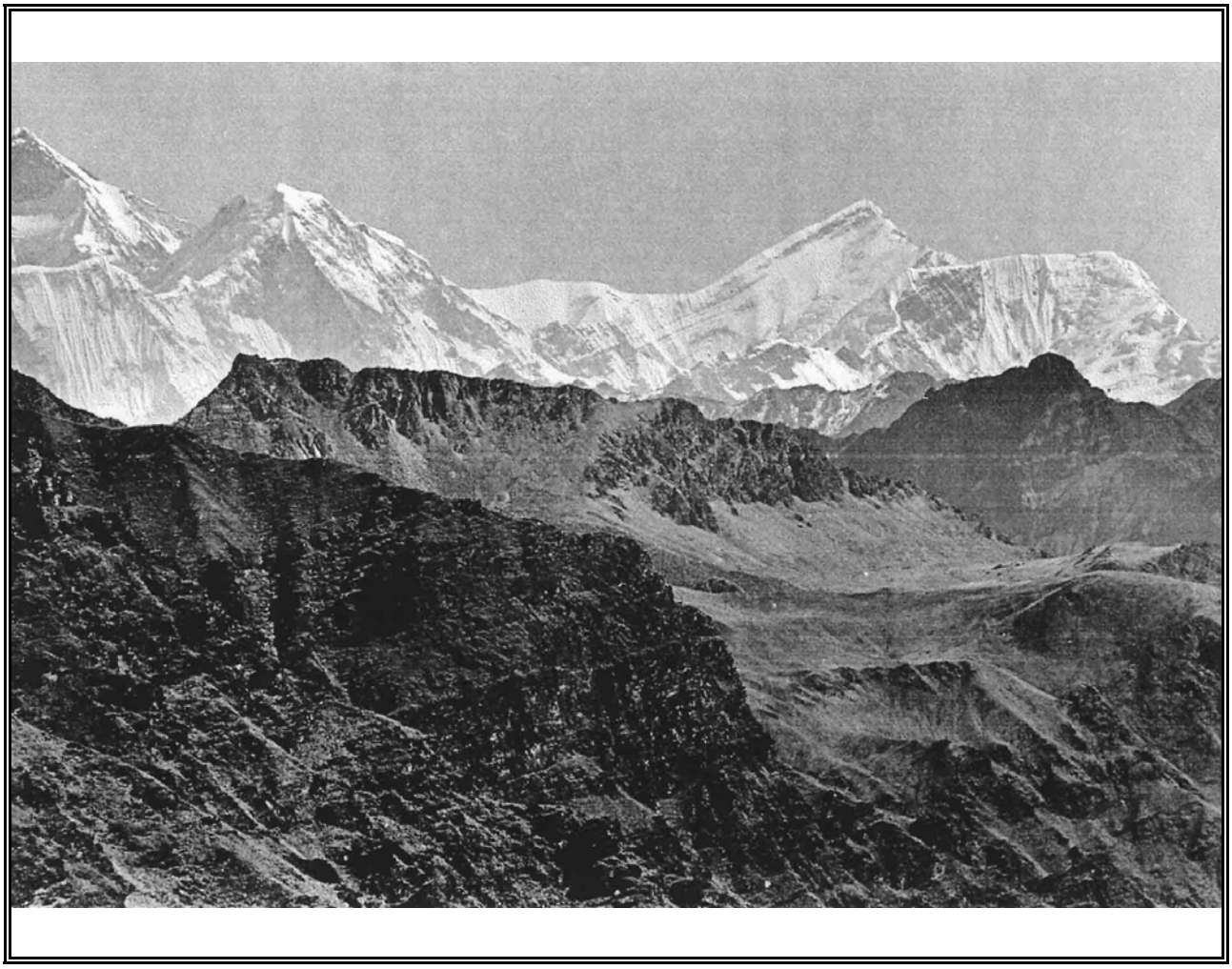


Figure 2–1. Typical snow leopard habitat in the Himalayas – Nepal's Dhorpatan Reserve (Photo: Paul Wilson).

then northwesterly along the Karakorum Range of Pakistan through the Hindu Kush Mountains into Afghanistan. From there the snow leopard occurs northward through the Pamirs into Tajikistan and the Alayskiy, Gissarskiy and Zeravshanskiy ranges; along the Turkestanskiy and Chatkalskiy ranges of Uzbekistan; through the Talasskiy Alatau and Kirgizskiy Mountains bordering Kyrgystan (Kirghizia) into the Kazakhstan Republic; and then through the Tien Shan bordering China's Xinjiang Autonomous Region north to the Zailiskiy Alatau and Dzhungarskiy Alatau of Kazakhstan, and eastward to the Nan and Karlik Shan ranges near the Mongolian border.

Figure 2–2. Remains of a blue sheep killed by snow leopard (Photo: Rodney Jackson).

The Kazakhstan populations are separated from populations in Russia (southern Siberia) and Mongolia by a gap of 200 km or more. In Russia, snow leopards are found in the Altai and the Sayan Mountains west of Lake Baikal. In Mongolia, they occur in the Altay, its subsidiary (and isolated) ranges, the Hangai Mountains, and the string of trans–Altay Gobi massifs. Reports of occurrence in the Kopet Dag Mountains of Turkmenistan are erroneous.

Country–by–Country Status

The following paragraphs summarize population estimates for each country, with habitat area based primarily on information in Fox (1989) and the Cat Species Survival Plan prepared by IUCN (Nowell and Jackson 1996). Using suitability criteria at a scale of 1:1,000,000, the authors modeled potential snow leopard habitat for each ranges country (Hunter and Jackson

1996, see frontispiece illustration). Table 2–1 shows potential good and fair habitat in each country and the percent in potential status.

Afghanistan. Available habitat totals 80,000 km^2, but no population estimate is available (Sayer 1980).

Bhutan. Available habitat totals 10,000 km^2 (Blower 1986 cited in Fox 1989b), but no population estimate has been made.

China. 400,000 km^2 of suitable habitat is available, with a population of about 1,400 (Fox 1989a), but this data excludes Sichuan and the potentially significant populations of Tibet (Xizang Autonomous Region), particularly along the Himalaya and southeastern edge of the Tibetan Plateau (which may increase the area of suitable habitat in China to 550,000 km^2). Estimates for Tibet and Sichuan Province are not presently available. Thus, the total Chinese population is more likely on the order of 2,000 to 2,500 animals (Jackson and Schaller, personal communication), including 750 in 170,000 km^2 of suitable habitat in Xinjiang (Schaller 1988a), and 650 in a 65,000 km^2 area in Qinghai and the neighboring Province of Gansu (Schaller 1988b), a mean density of one cat per 100 to 200 km^2. However, Schaller (1988b) estimated mean density at three to four snow leopards per 100 km^2 in parts of Qinghai Province, a density similar to that reported by Jackson et al. (1994) for parts of southern Tibet along the northern slopes of the Himalaya. A recent survey indicates the species is likely on the brink of extinction in Inner Mongolia (G. B. Schaller, personal communication).

India. According to Chundawat et al. (1988), suitable habitat totals about 95,000 km^2, with about 72,000 km^2 in Ladakh (nearly a third of which constitutes disputed border areas with Pakistan and China). Mallon (1984a) estimated the Ladakh population at 100 to 300 animals. Fox et al. (1991) estimate that about 400 snow leopards reside within a 52,000 km^2 area of northwestern India, with a nation–wide population of some 500 animals. This figure is derived using a mean density of one snow leopard per 110 km^2 in good habitat along the northern side of the main Himalayan Range (an area of 30,000 km^2) and one per 190 km^2 in lower quality habitat along the southern slopes of the Himalaya (22,000 km^2). These authors noted that small patches of prime habitat may support as many as one snow leopard per 15 km^2.

Mongolia. Available habitat totals 130,000 km^2 suitable habitat, with a population of 500 to 900 (Bold and Dorzhzunduy 1976), but recently estimated at about 1,000 (Schaller et al. in press) in an occupied range of about 90,000 km^2. These authors revised Mallon's (1984b) range map for Mongolia, and clearly substantiated the fragmented distribution of snow leopards in this country. The main populations occur in the Altay and Transaltai Gobi mountain ranges, with more isolated enclaves in the Hangai, Hanhohhly Uul and Harkhyra Uul mountains. Bold and Dorzhzunduy (1976) estimated a population of 190 to 250 snow leopards in a 6,600 km^2 area in the desert massifs of the southern Gobi, with a mean density of 4.4 animals

Table 2–1. Potential snow leopard habitat by country, quality category, and percent protected.

Country	Total habitat	Good	Fair	Percent protected
Afghanistan	117,653	32,748	84,905	0.3
Bhutan	7,349	1,269	6,080	57.4
China	1,824,316	290,766	1,533,550	6.3
India	89,271	33,996	55,275	14.4
Kazakhstan	71,079	14,775	56,304	1.7
Kyrgyzstan	126,162	32,783	93,379	1.1
Mongolia	277,836	21,180	256,656	2.5
Myanmar (Burma)	4,730	3,094	1,636	0.0
Nepal	27,432	12,388	15,044	26.7
Pakistan	81,016	32,348	48,668	6.6
Russia	302,546	41,166	261,380	4.5
Tajikistan	78,440	27,337	51,103	13.3
Uzbekistan	13,834	5,083	8,751	5.8
Disputed areas	3,064	773	2,291	0.0
All countries	3,024,728	549,706	2,475,022	6.0

per 100 km^2 for the Tost Uul range. Schaller et al. (1994) estimated at least 10 snow leopards roamed a 200 km^2 area of the Burhan Budai range.

Nepal. Available habitat totals 30,000 km^2 suitable habitat, population estimated at 150 to 300 (Jackson 1979), an estimate recently increased from 350 to 500 (Jackson, personal communication), based on computer modeling using a map–derived Habitat Suitability Index system (Jackson and Ahlborn 1990). Snow leopards are distributed along the northern border of Nepal and Tibet, with the largest concentrations occurring in the western part (Mugu, Dolpo, and Humla districts) of Nepal (Jackson 1979). Snow leopards have been sighted north of the Annapurna Range, in the Langtang Himal, Rolwaling Himal, Makalu, Walunchung, and the Kanchenjunga massifs. Jackson and Ahlborn (1989) reported densities of 5 to 10 snow leopards per 100 km^2 in the remote Langu Valley of west Nepal, slightly higher than estimated densities for Nar–Phu located north of Annapurna (M. Oli, personal communication).

Pakistan. Estimated area is 80,000 km^2 with a population of less than 250 animals according to Schaller (1976). He searched a 300 km^2 area in Chitral known for its snow leopards, but found evidence of only four, or possibly five animals. Assuming a mean density of one snow leopard per 250 km^2, the total population for Pakistan would be no more than 300. They occur in the Hindu Kush range in the Northwest Frontier Province's Chitral District, and through the Karakorum Range of the Northern Areas in Gilgit, Hunza, and Baltistan districts. Presence in Azad Kashmir has not been recently confirmed. Good populations are reported from Shimshal in Hunza, but no density estimates are available (Wegge 1988).

Former USSR. The estimated area of suitable habitat is about 400,000 km^2 with a total population of 1,000 to 2,000 animals (Braden 1982; Bannikov 1984). About two–thirds of the habitat is located in the newly declared republics of Tajikistan, Kazakhstan, Uzbekistan, and Kygrystan. According to Bannikov (1984) the population consists of 1,400 in Kygrystan, 200 in the Pamirs of Tajikistan, 50 in the Altay and Tuva of the Russian Union Republic, and 300 in Uzbekistan and Kazakhstan (180 to 200 in Kazakhstan), for a total of 1,950. The Tien Shan and Dzhungarsky Alatau support 400 to 500 individuals. According to Koshkarev (1989), there are 113 to 157 snow leopards in the Tien Shan in Kyrgystan, a mean density of 2.35 animals per 100 km^2. The following paragraphs detail estimates according to current political entities.

Russia. The amount of suitable habitat totals about 131,000 km^2 (Koshkarev, personal communication), with snow leopards being reported from the Altay and Sayan ranges bordering the People's Republic of Mongolia. Smirnov et al. (1990) estimates about 80 snow leopards reside in southern Siberia, including those animals that wander into Mongolian territory. There are no confirmed sightings from the Eastern Sayan Mountains, although tracks were reported by local herdsmen in the early 1980's (Medvedev 1990). The southern Siberian snow leopards are isolated from those of central Asia. Sopin (1977, cited in Fox [1989b]) estimates mean densities at 0.75 to 1.5 snow leopards per 100 km^2 in parts of the Altai Mountains, for a total population of about 40.

Kyrgystan (Kirgizia). Snow leopards occur in the Talasskiy Alatau and Ferganskiy Mountains, as well as the Tien Shan bordering China and Kazakhstan (Braden 1982; Koshkarev 1989). Koshkarev (1989) mapped snow leopard occurrence over much of its range in Kyrgystan, recording 20 inhabited areas (totaling 6,554 km^2), with an estimated population of 113 to 157 animals. Estimated density ranged between 0.8 and 4.7 animals per 100 km^2, averaging 2.4 animals. Over its entire range (65,800 km^2) in Kyrgystan, Kosharev calculated a mean density of about one snow leopard per 100 km^2.

Kazakhstan. In the south, snow leopards occur along the Khigizskiy Range and Tasskiy Alatau bordering Kyrgystan, in the Sarytau Mountains near Almata, and bordering China in the Dzungarsky Alatau, a place they are apparently most common. Annenkov (1990) reported about 65 to 70 snow leopards in a 8,200 km^2 area, giving a mean density of 0.83 individuals per 100 km^2. The Zailiskiy Alatau in the northern Tien Shan has about 20 leopards (Zhirjakov 1990).

Tajikistan. Little is known about snow leopard abundance in the former Union Republic of Tadzhikistan. Sokov (1990) estimates the number at about 200 to 300, significantly higher than previous estimates. They occur in the central and western parts in the Zeravshanskiy, Gissarskiy, Karateginskiy, and Petr Pervyi Mountains; in the Hazratishog and Darvaskiy Mountains; and in the Gorno–Badahshansk area, including the Pamirs.

Uzbekistan. Snow leopards are reported from the Turkestanskiy, Chatkalskiy, and Gissarskiy ranges bordering Tajikistan and Kyrgystan (Braden 1982), with a total population of about 50 (Sludskiy 1973, cited in Braden 1982). No density estimates are available.

There are no reliable estimates for the total snow leopard population. Numbers are presently placed at 3,350 to 7,000 in the wild (Fox 1994; Nowell and Jackson 1996).

Principal Threats

Hunting and Bone Trade

The primary threats to the survival of snow leopards are hunting for its valuable pelt (Figure 2–3) and bones, trapping of animals suspected of taking livestock, and the depletion (through hunting, poisoning or habitat loss) of natural prey species (thereby increasing dependence on domestic stock). Although pelts may fetch from 50 to 500 or more U.S. dollars, the international fur trade has greatly declined because of regulation, animal rights activism, and changes in western fashion, the primary market for fur coats. However, snow leopards appear to face significant threat from the Chinese medicinal trade, which places high value on bones of tiger and the larger felids (Figure 2–4). For example, local tribesmen in northern Nepal trade snow leopard bones for sheep along the border with Tibet, from where they make their way to China and southeast Asia. Medicinal products are marketed in the wealthy cities

such as Hong Kong, Seoul, Taipei, and Singapore, where demand greatly exceeds the supply. A few animals are captured for zoos, especially in China.

Figure 2–3. Illegal hunting and the bone trade are the principal threats to snow leopard (Photo: Rodney Jackson).

Conflict with Graziers

Conservation is complicated by the fact that snow leopards may prey upon livestock, causing economic hardship among herders and thereby eroding herder support for wildlife conservation. Since many herders depend entirely upon animal husbandry for their livelihood, the loss of even a few of their stock may be significant to their family's overall welfare. Predation on domestic livestock is a very complex and poorly understood natural process, with loss rates varying greatly between different areas or even over successive seasons and years. Greatest loss appears to occur in rugged terrain that offers high–quality habitat for snow

leopards, where native prey species (especially ibex, argali, and marmot) have been greatly reduced, and where herders are lax in their guarding practices. Livestock may constitute an important prey item in some areas; thus local herders may be unwittingly playing a key role in helping to preserve mountain biodiversity, and should be rewarded for a service they are providing to nature and society. Accordingly, the Trust is developing specific management procedures and conservation incentives to address such people–wildlife conflict.

Inadequate Protection

Most Asian governments lack the financial and manpower resources to adequately protect the snow leopard and its prey. Additional constraints include the cat's extremely remote and rugged range, harsh climatic and environmental conditions that prevail in many areas, the long international borders that are accordingly difficult to patrol, and a severe lack of trained staff to conduct surveys and develop management plans. International funds to help train and support management of wild snow leopard populations are becoming increasingly difficult to obtain.

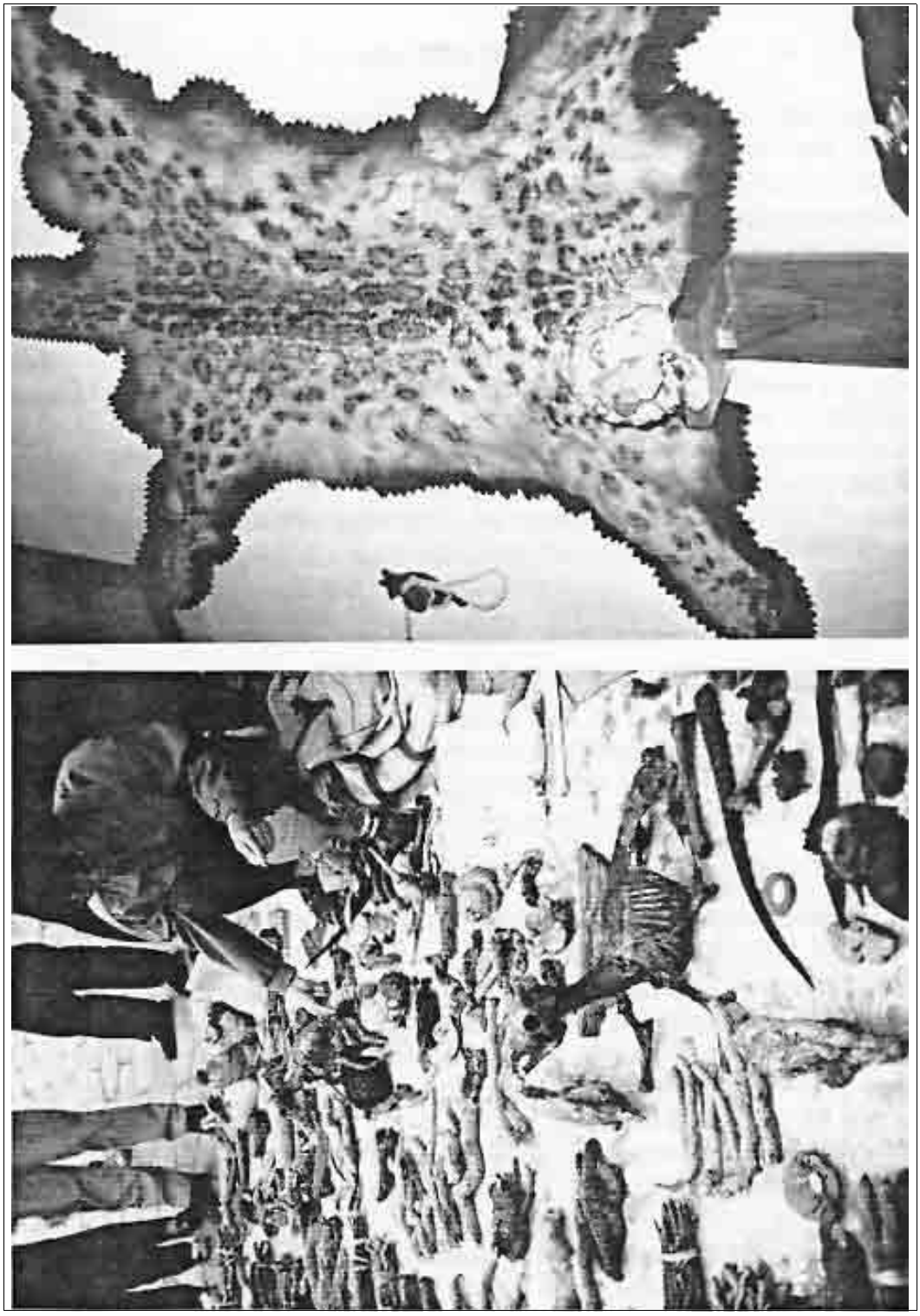


Figure 2-4. Pelts and bones of the snow leopard command high prices (Photo: Don Hunter).

Chapter Three – Basic Steps to Surveys

Introduction to Surveys

Surveys begin with a needs assessment, which in turn identifies which type of survey is most urgently needed and where each should be undertaken. Field work requires careful preparation to be successful. Irrespective of whether the surveyor is a highly trained scientist or not, a checklist is essential. Surveyors should work closely with their supervisors and staff to identify survey objectives, prioritize sites, and conduct field work in the most appropriate time of year. The most suitable area to survey should be chosen applying criteria offered in this handbook. Other requirements are an understanding of snow leopard and prey species' natural history and ecology, and an ability to recognize their sign. An appreciation of the study area's geography and human inhabitants is also desirable. Because the site is likely to be remote, and the cost of getting there high, other officials or persons knowledgeable about the area's wildlife, climate, topography and terrain, and road or access possibilities should be consulted. The best month of the year to travel there must be balanced with the best time for locating wildlife. The published literature must be reviewed, including ISLT's publications on snow leopard. Before leaving for the field, all essential supplies including clothing, food, and camping equipment, must be obtained and securely packed. Cooperation with local people is also vital to a successful outcome.

The more informed and well prepared the surveyor is, the more likely that he or she will be successful and produce a good report that reflects well on the responsible reserve or wildlife agency. This handbook contains a detailed account of the tasks to be undertaken, along with recommended methods and topics for the final report. The necessary data forms for each type of survey are included in the appendices, but they must be photocopied in sufficient quantity for field use.

There are many points to consider when developing standard methodologies. For example: Are the observers skilled and are they able to recognize snow leopard sign? What are the likely sources of bias and how can bias be minimized among different observers and geographic areas? Are the methods effective, sufficient, efficient, but not excessive? Do the methods suit the purpose? Are there other factors or variables that should be measured? Are the surveys costing more in time and money than they should? Are the transect routes and census sites selected to maximize the chance of detecting snow leopard or its prey, yet avoid over–estimation? How should sample areas be chosen? Are data being recorded in a consistent manner? Are distances being estimated accurately? Is the sample size adequate?

There are no easy answers to these questions, as it is not always possible to account for different conditions that exist among survey areas. Most census or sign sampling techniques are not precise, being heavily dependent on how the observer conducts the work. However, it is especially important that observers: (1) spell out in as much detail as possible the specific

reasoning applied in developing any relative density estimates presented in the report; (2) identify all important assumptions and provide a list of possible sources of bias or error; and (3) be as consistent as possible when applying survey techniques in different areas or times of the year. Show raw data in an appendix so that other biologists can directly compare results. For more information on assessing population abundance, see Caughley (1977), Overton and Davis (1969), and Bookhout (1994), as well as other references in Chapter 8.

Very little is known about the snow leopard's status, distribution and habitat, which is hardly surprising given its rarity, shy and elusive nature, and the remoteness of its mountain habitat. Rugged terrain makes status surveys logistically difficult. Yet baseline information is vital so that this cat, and other wildlife sharing the same habitat, can be protected to the benefit of future generations. To this end the ISLT and Biological Resources Division have developed a set of standard field techniques for assessing snow leopard, prey and habitat status in different parts of the cats' range. These survey methods, in two levels, are:

Presence–absence: Establishes the presence or absence of the snow leopard and its major prey species; identifies habitat types present and undertakes a *basic* assessment of conservation and protection needs. Presence–absence surveys are wide–ranging reconnaissance–level investigations undertaken by field staff, such as rangers, forest guards, and technicians. For example, a wildlife agency might mount a rapid series of presence–absence surveys to determine which of the country's nature reserves currently harbor snow leopard and its primary prey species. Although the surveys are designed to be performed by persons with limited educational qualifications, some training in the applications of SLIMS methods is highly desirable. ISLT (in association with participating agencies) offers field training workshops for resource personnel conducting presence–absence surveys.

Abundance: Provides detailed information on snow leopard, its prey and habitat, including relative abundance, distribution, and species habitat profiles.

Abundance surveys are more intensive, time–consuming, and quantitative investigations that can only be undertaken in a few places. They are oriented toward well–trained professional reserve managers, wildlife biologists, and others interested in undertaking more rigorous field surveys and inventories.

The level of survey to use depends on agency priorities, survey objectives, budget, and professional training. The first step is to identify the kind of information needed on the snow leopard, its prey, and habitat for a particular area. Gaps in baseline information for the region can help prioritize the type of survey needed. For example, little or no information may be available on the snow leopard or its prey in a particular area. Here, the primary objective would be to determine whether or not these species are present. A search would be made for snow leopard sign in the best habitat only, which may take only a few days. If snow leopards

are present, the objective could be expanded to map the cat's range with field searches that are much more wide–ranging. At the same time, sightings of ungulates could be recorded, using the resulting information to prepare distribution maps for each species of interest. In each of these cases presence–absence surveys would be used. On the other hand, the priority may be to estimate the numbers or relative abundance of snow leopards or prey species such as blue sheep and ibex (abundance survey). These surveys necessitate the use of more exacting and time–consuming field techniques. The basic tasks for surveys (Box 3–1) are described below:

Box 3–1. Basic tasks of snow leopard survey.

Key activity

- Identify survey areas
- Schedule and prepare for the survey
- Conduct the field survey
- Analyze survey data
- Report survey results

Identify Survey Areas

Develop a list of candidate survey areas and establish which are in most urgent need of a snow leopard (and prey species or habitat) status survey (Figure 3–1). The following steps will narrow the list of possible survey sites:

(a) identify areas within known or potential snow leopard range,

(b) determine which areas have the least amount of information and which have had no status survey in the last 10 years, and

(c) identify those existing or proposed nature reserves, national parks or protected areas in which the status of snow leopards should be established.

It is especially important to determine snow leopard, prey, and habitat status and distribution in protected areas and along the most important habitat corridors linking these reserves. Where status and distribution are not known, emphasis should be given to:

(a) reserves of large area (> 1,000 km^2) lacking baseline information,

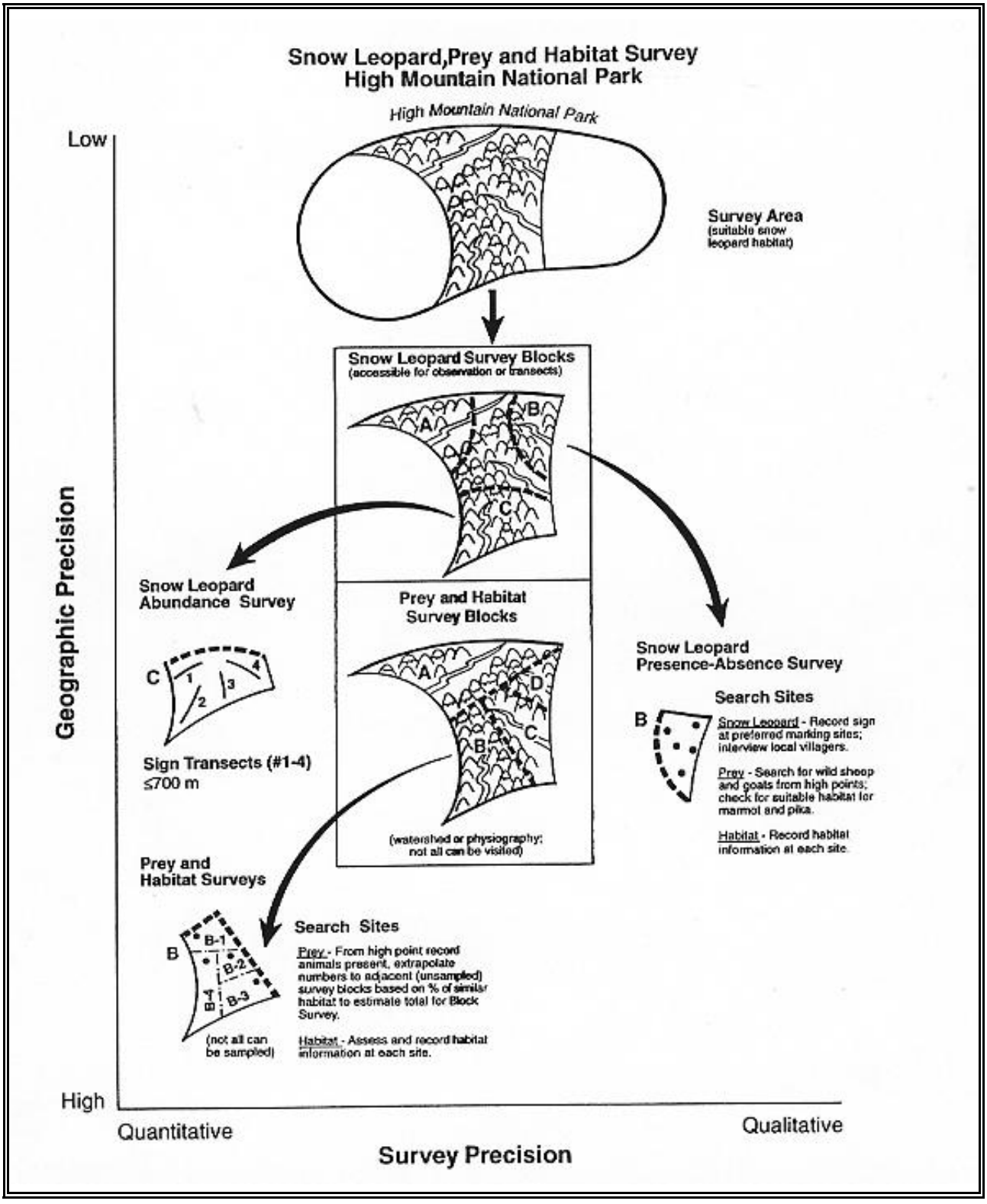


Figure 3–1. Snow leopard, prey and habitat survey areas.

(b) areas in core snow leopard range that support high quality habitat for snow leopards and other wildlife, and which appear good candidates for reserve status, and

(c) border areas with overlapping snow leopard habitat.

Box 3–2 indicates general habitat features associated with snow leopards.

.

Box 3–2. General habitat features associated with snow leopards.

- Mountain ranges (especially cliffs, rocky outcrops, uneven hill–slopes, drainages, and deep ravines).
- Elevations above 3,000 m, although they may be found as low as 1,000 m.
- Open shrub, grass, or herbaceous vegetation, rather than closed–canopied forest.
- Drier areas, especially those that receive less than 2,000 mm per year.
- Areas with relatively few human settlements and areas not unduly disturbed or heavily hunted.
- Any prey such as domestic or wild sheep and goats, deer, marmots, and game–birds.

Schedule and Prepare for the Survey

After reviewing SLIMS background information on detecting snow leopards in the wild, schedule the field survey for a time of year when access is easiest and when snow leopard sign is most likely to be detectable (Box 3–3 and Table 3–1) (see Chapter 4, and Appendix B, "Distinguishing Snow Leopard Sign from that of Other Species"). Generally, the best time of year to conduct the snow leopard surveys is late winter or early spring (January through April). By conducting surveys in mid–summer when weather is warmer, the surveyor risks having most sign destroyed by herds of livestock. After determining the means of travel, estimate how much time it will take to reasonably cover the area on the ground (at least 3 to 5 sites per 1,000 km^2 land area), and then finalize the field schedule and duration.

Box 3–3. Factors affecting survey schedule.

Snow leopard surveys are best undertaken when weather permits travel within the proposed survey area, when animals are most actively marking, and when sign is most long–lived. As indicated in Table 3–1, these conditions rarely coincide, so trade–offs have to be made between logistical factors and biological ones. The primary factors to consider are:

Time of greatest marking activity: Snow leopards mark most intensively during their mating season, early January through late March.

Period of most sign accumulation: This period coincides with the end of the mating season before spring or summer precipitation and human activity destroy sign.

Disturbance due to human activities: Livestock grazing can quickly destroy sign. As people move into spring and summer grazing pastures with their livestock, sign made during the past winter is obliterated. Seasonal movements to the high country occur as early as March or April and as late as June or July, depending on temperature and snowmelt.

Snowfall and other weather–related factors: While snowfall makes it easier to follow animal tracks, it also covers up previously made scrapes and other useful sign. Conversely, snow cover during winter surveys may provide excellent conditions to track snow leopards and to determine how many individuals reside in a particular area. In general, times of the year with repeated snowstorms are not appropriate for measuring scrape abundance. Rains erode sign rapidly, so that post–rainfall months are not appropriate. If possible, select dry, sunny months of the year.

Optimal substrates: One is far more likely to locate tracks in sandy sites than gravelly places. Scrapes in gravel are much more long–lived than scrapes made in sand.

Accessibility: Access may limit survey possibilities, making areas more difficult to survey that are far from roads or cut off by swollen rivers.

Snow leopard density, home range overlap, and related social factors: Besides being affected by weather, substrate, and amount of disturbance, sign longevity is also affected by the extent to which snow leopards mark and remark sites. This behavior seems to be related to cat density, sex and age structure, and home range overlap. Home range core areas appear to have more sign than less frequently used areas.

Table 3–1. Major factors influencing scheduling of snow leopard sign surveys.

Season	Factors affecting sign 1	2	3	4	5	6	7
Winter	*	–	+	*	+	–	–
Spring	+	*	*	+	*	*	+
Summer	–	+	–	–	–	–	+
Fall	–	–	–	*	–	+	*

Key to symbols:
+ optimal time
* acceptable time
– poor time

Factors affecting sign detectability:
1 = Intensity of marking activity
2 = Accumulation of sign
3 = Amount of human disturbance
4 = Amount of disturbance from weather
5 = Suitability of tracking medium or substrate
6 = Access and travel conditions
7 = Availability of "relic" sign

Organize transport, field logistics, food and camping supplies and obtain all necessary instruments and field materials for undertaking the survey. Make a list of all items and check them off as each need is met. Make a list of all equipment and supplies needed, and obtain these as soon as possible (Box 3–4, Equipment List). This preparation helps avoid unnecessary delays that may adversely affect the survey. Transportation into the field will be the largest expense item and one of the surveyor's greatest constraints. When possible, schedule work to fit with that of others to reduce costs or demands on scarce vehicles. Once in the field, try to travel from site to site using the most cost–effective and readily available form of local transport, such as horses, camels, donkeys, or simply on foot. If possible, include a local person on the team to translate and facilitate contacts with local people. Ask for assistance from persons knowledgeable in organizing field logistics or who have visited the area and can recommend the names of local residents willing to work as guides. Gather and review background information on the environmental conditions (human geography, topography and terrain, weather, vegetation, wildlife, etc.) in the proposed survey site. Acquire as complete knowledge as possible of the area's natural history (although this task will depend on library facilities and literature available).

Box 3–4. Suggested equipment list.

Required:

- Topographic map(s) (preferably at a scale 1:50,000 or 1:100,000)
- Map of standard ecotypes or vegetation communities
- Natural history guide and standard manual for region's fauna
- Field notebook (spiral–bound or loose–leaf note book in which to log daily activities and observations)
- Data forms
- Pencils, pens, eraser, ruler, and tracing paper
- Binoculars

Optional:

- 35–mm camera and film (black–and–white or color print)
- Plastic bags for collecting scats and other items
- Altimeter and magnetic sighting compass – preferable
- Spotting scope
- Cassette recorder
- GPS (global positioning device)
- Tally–counter
- Tape measure
- Track tracer (to make life–size tracings of tracks)
- Plaster–of–Paris (to make castes of tracks)
- Other: Warm clothing; camping equipment; food and cooking supplies

Conduct the Field Survey

These methods vary with each level of survey (presence–absence or abundance) and the aspect studied (snow leopards, prey species, or habitats). Once in the field it is important to remain organized. Data forms and field equipment should be checked and made ready for early departures from camp. Time in the field is usually short, so it is important to plan each day's activities, guided by the objectives of the survey and the area to cover. This is the time when good pre–planning pays off.

Sign placement. Snow leopards tend to leave their scrapes in relatively predictable places, such as the base of cliffs (Figure 3–2), beside large boulders, on knolls and promontories, at bends in trails, or along other well–defined landform edges (Schaller 1977; Koshkarev 1984; Mallon 1987; Schaller et al. 1987; Ahlborn and Jackson 1988; Fox 1989) (Figure 3–3; Box 3–5). Landform edges are defined as the sharp point of contact between two
topographic features. Prime examples include a sharply profiled ridgeline leading down toward a stream confluence, the entrance to a steep–sided gorge, the edge of a steep, abrupt river bluff, or the base of a cliff.

Figure 3–2. Two snow leopard scrapes at the base of a cliff in Ladakh, India (Photo: David Mallon).

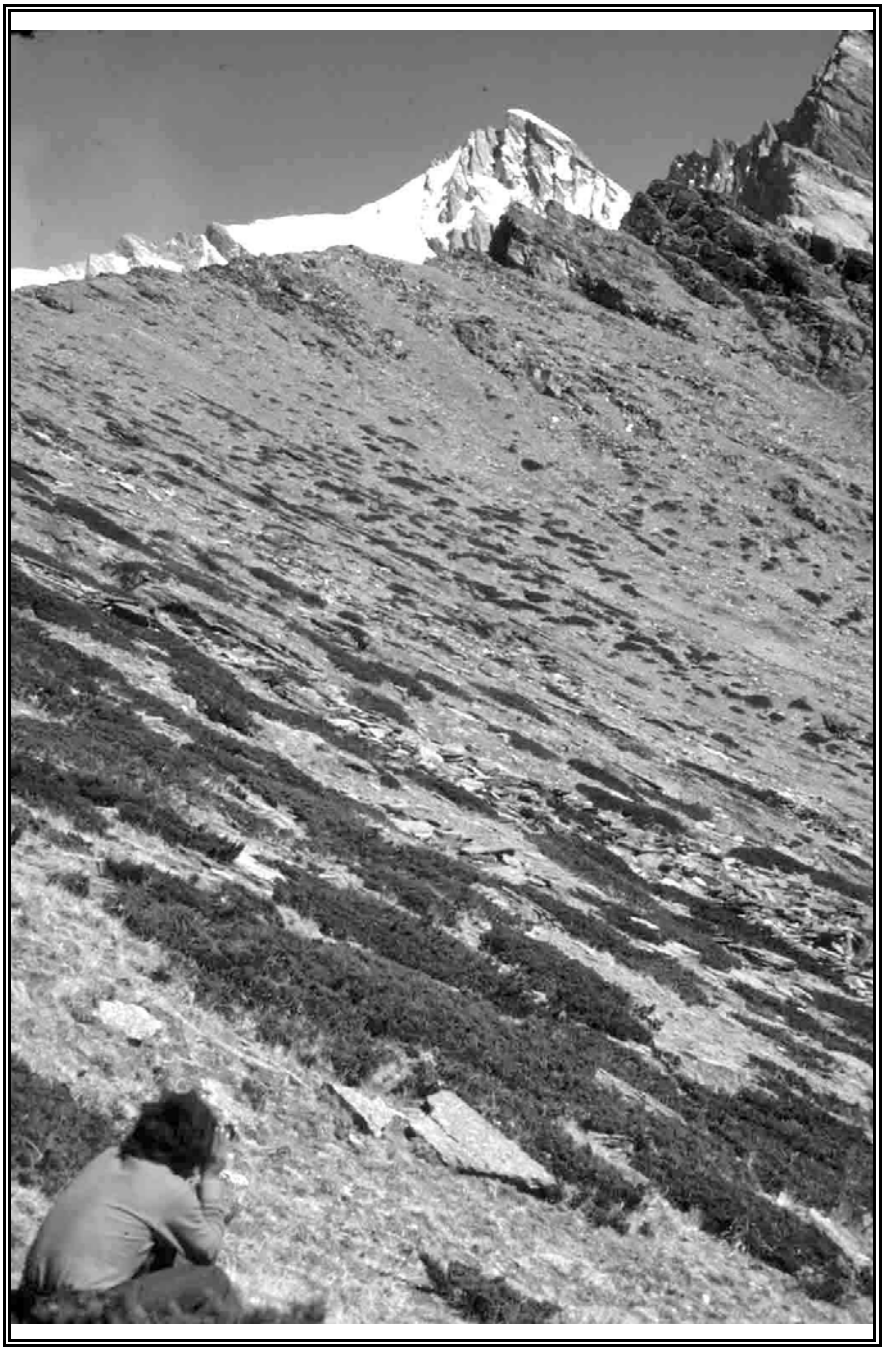


Figure 3–3. Sharp–edged ridge that separates a cliff from adjacent, less steeply inclined areas. The smooth sloping area is important foraging habitat for blue sheep, while the cliff offers escape cover (Photo: Rodney Jackson).

Sites with poorly defined topographic features and no obvious landscape "edge" tend to be used significantly less for marking by snow leopards. In Nepal, sign density was greatest along transects near well–defined stream confluences, at the entrances to gorges, or along prominent, narrow ridges (Figure 3–4). Significantly more sign was deposited within the overlapping core–use areas visited by different radio–tagged cats.

Analyze Survey Data

Though designed for ease–of–use, presence–absence surveys are a scientifically valid approach to determine the general status of snow leopards in broad geographic areas. Assuming it is impossible (or at least impractical) to survey entire regions, the surveys rely upon the presence of snow leopard sign at strategic search locations. Data analyses use survey block summaries to draw conclusions on (1) the presence–absence of snow leopard and prey species,

(2) major threats, and (3) management recommendations. These are qualitative methods that lead to personal judgments supported by physical evidence documented in the survey forms. Unlike abundance surveys, there is no statistical basis for the conclusions.

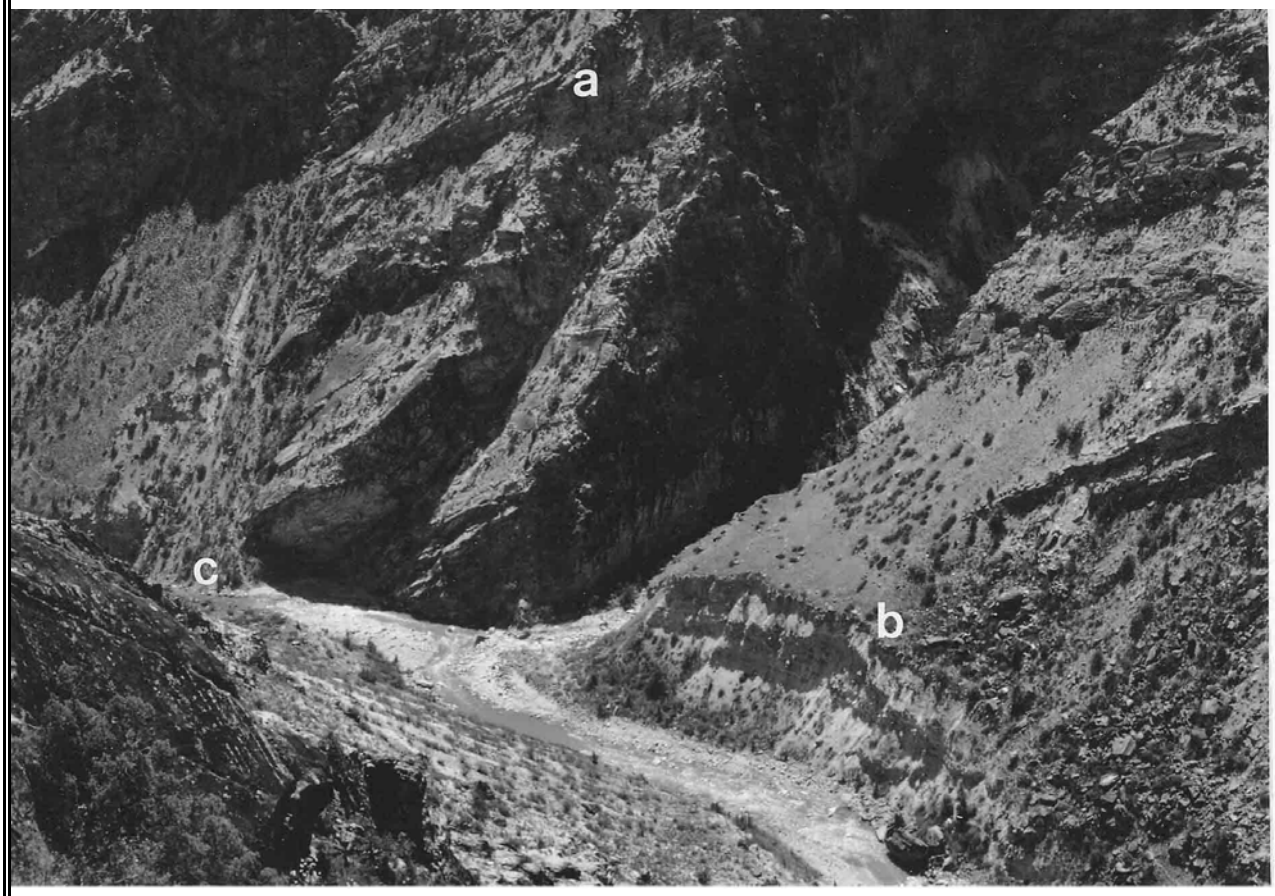
Box 3–5. Optimal sign detection.

The best places to search for snow leopard sign are:

- along the crests of well–defined ridgelines near where they bisect a major stream or river confluence;
- the base or crest of a cliff, riverine bluff, or escarpment;
- a well–defined mountain pass or in saddles along a high ridgeline;
- near the entrance to a deep, narrow gorge;
- a promontory point on a steep hillside or where the base of a mountain spur intersects a valley or plain;
- at the base of isolated, prominent rock boulders or outcroppings; and
- any other well–defined topographic or landscape edge, including a trail.

Because snow leopards tend to move along topographic edges, searches should avoid:

- the middle of wide valleys or along wide, open slopes;
- along stream beds (unless there is a well–defined topographic edge); and
- along trails that are well used by livestock or people.



"A" shows a major ridgeline; "b" is a reverine bluff/terrrace edge; and "c" is the of a cliff. Travel options for snow leopard are clearly delineated where two rivers or large-sized streams converge.

Figure 3–4. Major stream confluences in the Langu Valley of western Nepal, showing local topographic features preferred by snow leopard for marking (Photo: Rodney Jackson).

After all the surveys are completed, the analyst must collate and analyze block summaries. When snow leopard data are abundant in all survey blocks, the conclusion is evident. When sign are scarce or absent, however, the analyst must dig deeper to come to a conclusion, for it is possible for snow leopards to be present when the physical evidence suggests otherwise. This is a situation where the analyst must be familiar with the survey technique and general

snow leopard ecology. When snow leopard sign is absent, the analyst must rely on all other information on the data forms to reach a judgment. Prey species, habitat, and local interview data may point to the presence of snow leopards even though no sign was found during the survey.

The analyst uses the survey data to support qualitative judgments on snow leopards, prey species, threats, and management recommendations for the survey area. The survey forms are the critical analytical unit and should be carefully stored for future reference. Over time, as survey conclusions are mapped for large regions, trends will emerge that will help guide conservation programs.

Report Survey Results

Contributors are urged to compile and submit reports as soon as possible after returning from the field. These observations are important to snow leopard conservation. Contributors are also encouraged to write a report for publication in the International Snow Leopard Trust's newsletter, *SNOWLINE*, which is circulated to interested parties throughout the world.

Provide a detailed account of objectives, methods used, names, and affiliation of the persons conducting the field work, the dates spent in the field, location and number of transects conducted, habitat and terrain features of the area surveyed, sign encountered, and other observations and recommendations for managing wildlife resources, including snow leopard prey and other rare species. Include a general location area map, as well as more detailed maps and photographs to enable the reader to better understand habitat available in the area investigated. The report should contain tables indicating sign frequencies for all transects combined.

Copies of the report and its findings should be submitted to government agencies and the local SLIMS node. Include copies of the original data forms as well as tables showing the sign items observed along each transect.