Chapter Five – Prey Species Survey Methods

Purpose and Background

A knowledge of prey density and predator–prey ratios would help set limits for validating snow leopard numbers in a particular area. Clearly, there must be sufficient prey to support the predicted predator population. Field studies are needed to better establish how many blue sheep or similar large prey animals are needed to sustain predation by snow leopard at varying densities, with or without the presence of a buffering species like marmot.

A snow leopard population is dependent on the number of prey animals present in the same general area. A snow leopard requires approximately 1.5 to 2.5 kg of meat per day, or 40 to 45 g of food per kilogram of its body weight daily (Fox 1989). Because about 30% of ungulate prey consists of unusable items such as bone, skin, or stomach contents, an adult snow leopard would be expected to consume between 700 and 1,200 kg of prey annually. Jackson and Ahlborn (1988) estimated that a population of 150 to 230 blue sheep are required to sustain a single snow leopard without depleting the prey base, but this number could be lower in areas where livestock, marmot, and other small prey are also taken (Oli 1993, 1994a; Chundawat 1994).

The snow leopard is an opportunistic predator capable of killing prey more than three times its own weight. Therefore, it may potentially prey on most herbivores found in the same range except for fully grown yak or wild ass *(Equus hemionus)* (Schaller 1977). In general, food habit studies indicate that the primary prey of the snow leopard consists of the dominant wild ungulates of the region, along with a variety of smaller birds and mammals. Blue sheep and Asiatic ibex are the most common prey items, along with domestic stock, musk deer (*Moschus* spp.), pikas, hares and gamebirds (snowcocks, *Tetraogallus*, and chukar partridge). In parts of the Himalayan region, tahr (*Hemitragus jemlahicus*), markhor *(Capra falconeri)*, urial *(Ovis orientalis)*, and goral (*Nemorhaedus goral)* are killed in addition to blue sheep and ibex.

In the Tien Shan, Dzhungarsky Alatau, and other ranges of the former USSR, red deer and roe deer constitute important prey along with wild boar. Snow leopards may occasionally take Tibetan antelope *(Pantholops hodgsoni)*, Tibetan gazelle *(Procapra picticaudata)*, and white–lipped deer *(Cervus albirostris)* along the Kunlun and on the Tibetan Plateau. Argali sheep *(Ovis ammon)* are now too rare to be preyed on much by snow leopards. Wild ass foals *(Equus hemionus kiang)*, young camels, and subadult wild yak *(Bos grunniens)*, may constitute another rare item in the cat's diet (Fox 1989).

Livestock are commonly killed by snow leopards, wolves, and other predators, but loss rates vary seasonally and among different areas. Typically, most losses occur during winter and early spring. Some places suffer almost no loss despite the presence of many snow leopards, while in other places one or two cats have been known to cause considerable damage. Because marmots hibernate for five or more months of the year, they are only available during late spring, summer, and early fall. Marmots probably play a very important role in helping reduce predation on domestic stock (Schaller et al. 1988; Oli 1993), but the highest livestock loss tends to occur in areas where the natural prey base has been depleted through poaching, habitat destruction, or other factors, or where calves of bactrian camels (*Camelus bactrianus*) are being poorly guarded.

Government authorities consider argali, blue sheep, ibex, markhor, deer, Tibetan gazelle, and most other large prey species as important sport hunting or trophy animals that could attract much needed revenue, provided hunting programs are well–managed and harvests set to sustainable limits. However, species such as argali and Marco Polo sheep are becoming too rare in some places to support even small hunting harvests. Consequently, updated and reliable status and distribution surveys are needed to establish current population levels of all wild ungulates. Data are needed on distribution patterns (past and present), population size, sex and age structure, and general demographic patterns (especially recruitment and mortality rates). Agencies responsible for managing wildlife should also accrue baseline information on each key species' spatial and habitat requirements, forage requirements, preferred food–items (diet), escape cover and birthing area requirements, and migratory or movement patterns (many species make use of seasonally separated habitats). Such data are particularly important in light of the rapid changes to Central Asia's rich and unique ungulate fauna due to the expanding human population, road construction, mineral exploration and extraction, livestock development, and many other economic activities.

While presence or absence of a particular prey species can be relatively easy to establish, it is considerably more difficult to estimate population size with any degree of accuracy and reliability. Some species (for example, musk deer), are secretive, small, or inhabit cover–rich sites. Others are restricted to rugged mountain terrain (e.g., blue sheep, markhor, ibex), or have been largely extirpated and are now seen only in remote places (e.g., wild yak, Marco Polo sheep, urial, argali sheep, and Tibetan antelope). Population counts are time–consuming and subject to numerous sources of error, and resulting data are often difficult to interpret. Rarely can more than a small portion of an animal's range be checked, so regional estimates must be based on extrapolated estimates, adding to the inaccuracies. Density estimates can vary widely depending on habitat quality, the methodology employed, skills of the observer, and the amount of effort expended in locating all individuals or groups inhabiting a particular area. Given these factors, the need for standard field methods is critical. This handbook provides basic recommendations for counting large herbivores. The techniques selected are especially designed for mountainous terrain, although some modification may be needed for special conditions occurring within some areas. However, it is imperative that modifications to the procedures listed here are scientifically valid and that the reasons for modifying the procedure are explained in the final report. The report should provide a full account of the methodology employed. Search efforts – number of replications, size of area(s) censused and so forth – must be described to help explain census results.

FIVE – PREY SPECIES SURVEY METHODS

One could conduct roadside strip counts for hares, counts of burrows for marmot, or call counts during the summer, and territorial call counts for breeding pairs of snowcock, but this handbook does not describe these methods for several reasons. First, counts do not always reliably reflect actual numbers due to differences in activity or burrowing behavior. For example, marmot group sizes vary from one colony to the next and some marmots are more active than others. Colonies tend to be clumped and can be easily overlooked, especially when animals are not active above ground. Because snow leopard surveys are usually conducted in late winter or early spring, marmots may still be hibernating and thus no fresh sign would be present at burrow entrances. Second, counts may be greatly complicated by the large fluctuation in numbers that animals such as hares and small rodents experience from one year to the next. Direct counts depend on a species activity cycle and its ease of visibility. For example, seasonal differences in social behavior may affect group size and detectability, as in the case for snowcock and many gamebirds. Finally, many small prey species are extremely patchy in their distribution patterns, making extrapolation of counts inaccurate. Therefore, as part of the report on large mammal species, this handbook requests the following information on small– and medium–sized prey animals:

1. Provide a list of species known or suspected to occur in the project area, with comments on their status and distribution where information is available. Indicate relative abundance using broad terms such as scarce, common, or very common.

2. Identify major threats and protection measures required.

3. When possible, collect and analyze scats to determine presence–absence and relative abundance in the diet of snow leopards in the area (see Oli [1993b] for the procedures involved).

Abundance Survey

Objectives

1. Conduct herd counts (census) and estimate population sizes for key ungulate prey species.

2. Characterize important ungulate habitats and list factors likely to limit prey abundance.

3. Make recommendations for the management and protection of all key prey species.

FIVE – PREY SPECIES SURVEY METHODS

Outputs

1. Completed prey species survey forms (Form No. 3).

2. Report describing status, abundance, and distribution of key prey species.

3. Map showing location of search sites and locations where prey species were observed.

4. Descriptions of habitat types found within the survey area.

5. Black–and–white photographs of the survey area.

6. Suggestions for improving protection and management of prey species and their habitat.

Note: Prey species surveys are conducted concurrent with habitat assessment and use the same data forms (Form No. 3).

Methods

Two basic types of census methods include: *Total counts*, involving counts of *all parts* of the survey area for a particular species (i.e., all sites that could offer potential habitat for the species in question). This method may only be practical for diurnal ungulates inhabiting open country, but even then not over vast areas. *Sample counts*, involving censuses in selected sub–areas and extrapolation of data to the total habitat (or area) available to the species in question. Sample counts are clearly more practical.

In addition, counts can be *direct*, involving actual sightings of the animals themselves, or *indirect* and based on sign, such as the number of pellet groups which serves as an index of relative abundance (e.g., Barnes and Jensen 1987). Indirect methods are not considered in this handbook, but could possibly be used for secretive species such as musk deer (Green 1987b). There are two basic types of direct counts: (a) *strip or line transects*, that are best suited to species occupying open plains with sparse vegetation, such as Tibetan gazelle, Tibetan antelope, argali, urial, and kiang; and (b) *fixed point counts*, a technique more suited to broken, mountainous terrain and those species which live in herds. This handbook recommends that the fixed point count be used to census mountain sheep and goats, including blue sheep, argali, ibex, and other ungulates dependent on water holes. However, a brief description of line transects is provided for those interested in censusing plains ungulates.

Form No. 3. Prey species survey and habitat assessment form.

Observer(s): ______________________ Date (d/m/y): ______ Observer Form No. ______________ Page ___ of ___

Location: ____ Survey Block No. __________________________

Administrative District: __________________________________

Column number and item	Search site: ________ Herd no: ________	Search site: ________ Herd no: ________	Search site: ________ Herd no: ________	Column number and item	Search site: ________ Herd no: ________	Search site: ________ Herd no: ________	Search site: ________ Herd no: ________
1. Species				9. Rangeland use			
2. Total no. in group				10. Habitat/ vegetation			
3. Distance (m) to group				11. Landform ruggedness			
4. Sex and age composition				12. Dominant topographic feature			
Unidentified				13. Position on slope			
Adult females				14. Elevation			
Lambs				15. Slope			
Yearlings				16. Aspect			
Adult males				17. Distance to: – Escape cover			
Class I				– Cliff			
Class II				– Landform type			
Class III				– Topo–graphic feature			
Class IV/V				– Human habitation			
5. Search time (hrs/ min)				– Livestock: Herd Road			

Column number and item	Search site: ________ Herd no: ________	Search site: ________ Herd no: ________	Search site: ________ Herd no: ________	Column number and item	Search site: ________ Herd no: ________	Search site: ________ Herd no: ________	Search site: ________ Herd no: ________
6. Percent area searched				– Water source			
7. No. days sampled				– Salt lick			
8. Activity				– Other – Habitat edge			

COMMENTS *(other relevant observations)*: ____

____

____

____

____

Strip or Line Transect

Also known as the King Strip Method [see Wildlife Investigation Techniques manual edited by Schemnitz (1980) and Bookhout (1994)], this approach works better for open savanna country, rather than areas with dense vegetation or rugged topography. It is poorly adapted for enumerating secretive species and most predators. It relies on observers who are skilled in spotting fleeing animals and in estimating sighting distances and viewing angles (Burnham et al. 1980). If the census area contains a mixture of different vegetation types with differing visibilities, then the population of each habitat must be computed separately. One needs a good vegetation map or aerial photograph to locate, map, and calculate the coverages of each major vegetation cover type. Each transect must be separated by sufficient space from the next to minimize the chance of animals being chased ahead of observers and being counted more than once. Counts from cars may be biased by the visibility of the car (for example, its color or size), the extent to which animals associate danger with vehicles (a problem if people have hunted them from vehicles), how fast the vehicle is driven, the number of observers in the vehicle, and their skill in spotting wildlife. Horses may be substituted for vehicles. Other options are aerial counts and low–level photographs. But it is assumed that airplanes and helicopters are either not available or are far too expensive to justify their use. This is unfortunate because aerial counts are capable of obtaining accurate population estimates over large areas.

All strip or line transect counts need to be run at a consistent time of day, preferably when animals are active and lighting conditions are best for spotting them. Observers must constantly practice estimating distances (Norton–Griffiths 1979).

Because snow leopards rarely prey on plains animals, this handbook focuses on fixed point counts. Researchers interested in strip counts should consult the literature for more information before undertaking surveys. Burnham et al. (1980, 1985) provide a detailed account of density estimation from line transect sampling. For additional information on the various factors influencing the outcome of population counts, read Chapter 9 of the publication titled, *Research and Management Techniques for Wildlife and Habitats* (Bookhout 1994).

Identify Survey Areas

Outline *survey blocks* encompassing entire river basins or watersheds and contiguous mountain massifs, ranging in size from 75 to as much as 1,000 km^2 (Figure 3–1). Consult with knowledgeable persons to determine which survey blocks would most likely support the best populations of each candidate species and outline these on a topographic map with a scale of between 1:50,000 and 1:250,000.

FIVE – PREY SPECIES SURVEY METHODS

Schedule and Prepare for the Survey

Optimal times for surveying ungulates will vary according to the species and its social organization, behavior, habitat preferences, and seasonal movements. For example, ungulates such as ibex, blue sheep, and argali, in which group size and composition fluctuate, are probably best censused during the rut when herds are mixed and animals are generally more visible and somewhat less wary. By contrast, Tibetan gazelle may be more dispersed during the rut because males space themselves out as they vie for territories and females. Tibetan antelope may be easier to count when migrating, although usually only in very remote areas, and not all populations are migratory. Ibex and blue sheep are best counted between winter and early spring when they occur at lower elevations. During summer and fall many animals may be driven to the more remote, higher, and inaccessible pastures by pastoralists and herds of their livestock. In late spring, females withdraw from the herds to give birth, often in places with dense cover. During the following few weeks they are very secretive and wary. By contrast, males congregate in bachelor herds and are often very easy to locate and observe.

Be sure to review background information on prey species expected to occur in the proposed survey area, and review past annual counts (if any exist).

Conduct the Field Survey

Designate search blocks and search sites and locate observation vantage points. Once survey blocks have been selected, locate suitable search sites in which to attempt a count of all animals present. Survey blocks, as well as smaller search sites, form the basic sampling unit for an ungulate census (Figure 3–1). They are derived by dividing a major watershed or mountain massif into relatively small sections, each of which is manageable in terms of its size (10 to 100 km^2). These search blocks are delineated on the basis of subdrainages, tributary valleys, or particular mountain slopes and basins.

Very few search blocks are likely to have a single place from which all animals present can be seen and counted. In broken areas, it is often impossible to spot an animal more than 300 to 500 m away. Differentiating its sex and age class at distances beyond 500 m is equally difficult, even if a powerful telescope is used. Therefore, divide each block into search sites – small, contiguous areas in which one can search for ungulates from no more than one or two high vantage points (fixed search points) and yet see at least 60% of the land–surface present. Search sites should offer a high likelihood of locating most or all animals present within an hour or two of observation. Examples include the upper portion of a tributary drainage, a particular hill–slope and adjacent ridgeline, a bowl or basin–like area, or a contiguous mountain meadow. Counts from a series of search sites provide the basis for estimating population size within the entire watershed or census block.

Using the topographic map, examine contour lines and physiography to locate several search points for each search site. Use colored pens to trace boundaries for each search block and search site, naming and numbering each. Boundaries should follow natural landform edges, such as major ridgelines and drainages. The end–product of this task is a map indicating search blocks and search sites.

Prioritize search sites and develop a schedule for conducting counts. In developing a sampling strategy, one needs to ensure that the chance of double–counting animals is minimized and that the full–range of habitat conditions present within the survey area are sampled. This permits survey site data to be more reliably extrapolated to unsurveyed sections. There are several possible sampling strategies: (1) survey all blocks (survey blocks, census blocks, and search sites), but this method would obviously be too time–consuming and expensive; (2) conduct counts only in a randomly selected sampling of census blocks and search sites; or (3) use a stratified sampling procedure for investigating each distinctive habitat type in the approximate proportion to its occurrence in relation to the total area under investigation. For example, if 20% of the area is high–quality blue sheep habitat and the rest is marginal because of a paucity of escape cover (cliffs or broken, rocky terrain), then ensure that no more than 30 to 40% of effort is devoted to sites thought to support the best blue sheep populations. The remaining effort is devoted to surveying suitable habitat.

Once in the field, interview local residents to determine which areas might support the best numbers of each survey species, and in which areas the numbers might be low because of less favorable habitat, shortage of forage and cover, or greater human disturbance. Finalize boundaries of survey blocks accordingly and sample these in general proportion to their occurrence. Search sites, where actual counts are conducted, should be selected as randomly as possible. For example, they could be numbered and selected using a table of random numbers (Appendix C). Under this procedure, the investigator searches between 10 and 40% of each search block. Other criteria for selection of search sites include ease of access, size, number, and location of vantage points from which to scan the area, the extent to which visibility may be restricted by topographic features (such as high ridges, deep drainages, rocky outcrops, or other broken terrain), and the quality of habitat present.

Ideally, the counts should be conducted over two or three successive days. One–time visits to a particular search site should be avoided, because it is easy to overlook animals. On the day visited, for example, one or more herds may be hidden behind a small ridge or in a high drainage. Another reason for repeated counts are the changes in herd size and composition that may occur over successive days. However, the less broken the terrain, the smaller the sampling effort required. A single day may suffice in areas with very good visibility. Repeated counts also permit establishment of statistically significant confidence limits, provided sample sizes are adequate (see Overton 1971).

Schedule counts in such a way that sampling areas are *minimally disturbed* by the presence of humans. Undertake counts closer to camp first and try to select access routes that minimize disturbance of the herds before they are censused. The end–product of this task is a field schedule for sampling each designated search block in the area to be surveyed.

Conduct fixed–point counts. Conduct field visits to each search site, undertaking searches from high vantage points to locate animals within given sighting distances, using powerful binoculars (8 or 10 power) or preferably a spotting scope (15–45 X) mounted on a steady tripod. The objective is to locate as many of the individuals or groups using the area as possible. Surveys are best undertaken early in the morning when animals are more likely to be feeding, before haze has developed, and with the sun behind the observer's back. Late afternoons are also an appropriate time to search for ungulates. They can blend remarkably well into the background, especially if the ground is rocky or similar in coloration, and may be seen only when they move. Try to climb onto high ridgelines and look downward into adjacent valleys. Alternatively, one could view a valley slope from the opposite slope, but remember that animals may detect the observer first and leave the area before they are counted. Be aware of their well–developed sense of smell; it is better to approach the observation site from downwind and view the area to be sampled from a distance that minimally threatens any animals present. Consider the sources of bias that may occur in your census (Box 5–1).

Recording data. If possible, whenever an individual or group is spotted, classify each animal according to its sex and age class, using standard criteria and age classes (for example, see Appendix B for age classification of blue sheep, where a relatively close approach – 300 to 500 m – is possible). Use the wide–angle lens of the spotting scope (22 X) to search hill–slopes, and the high power zoom (40–60 X) to determine the sex and age of individuals. Make sure the scope is mounted on a secure tripod, out of the wind. The more animals one can reliably classify, the better, for this level of detail allows the observer to determine whether a group is seen on more than one occasion. It also provides invaluable information on population structure.

Make every effort to mark the position of each sighting on the topographic map, giving it a unique, consecutive number. Record the time and date as well as pertinent observations such as habitat and behavior (see Form No. 3). Information to be gathered includes:

(a) number of animals observed and activity at first sighting;

(b) observation distance in meters at first sighting (i.e., straight–line distance between observer and animal);

Box 5.1. Some sources of bias in censusing.

- Detection depends on the searching skills of the observer, prey camouflage characteristics, and their ability to detect and respond to human intruders. Animals that flee, especially at close distances, are more likely detected than animals that sense humans at great distance and move away unseen.

- Vegetation and other horizontal cover is a major constraint when searching for animals in forests, shrublands, rocky areas, or when the land surface is obscured by other physical obstacles such as drainages, gullies, depressions or bowls, and hillocks.

- Large groups (bands or herds) are more easily detected than small groups or individuals, especially if their escape draws the observer's attention.

- Most species are more easily detected when foraging as opposed to bedding and resting.

- Detection is especially hampered in areas with broken terrain or sites with short observer–to–horizon distances (in this case, the animals can sense the observer's presence by scent or sound, enabling them to move away undetected).

- Most ungulates are difficult to detect when their color blends in with that of the background.

- Detectability is influenced by social organization and structure: nursery or female groups are usually more vigilant than bachelor male groups.

(c) sex and age composition;

(d) habitat information for site of first observation, including land–use, habitat type, vegetation cover and type, landform type, topographic feature present and distance to escape cover. Use the codes provided in Table 5-1.

Table 5-1. Codes to Form 3. Prey species surveys and habitat assessment.

Column number	Item	Code	Description
1	Species Code (incomplete)		
	Equus hemionus kiang	EQHEKI	Kiang
	Bos grunniens	BOGR	Wild yak
	Capra ibex sibirica	CAIBSI	Siberian ibex
	Ovis orientalis vignei	ORORVI	Urial
	Ovis ammon hodgsoni	OVAMHO	Tibetan argali
	Ovis ammon darwini	OVAMDA	Gobi argali
	Ovis ammon karelini	OVAMKA	Tien Shan argali
	Ovis ammon polii	OVAMPO	Marco Polo sheep
	Capra falconeri	CAFA	Markhor
	Pseudois nayaur	PSNA	Blue sheep
	Hemitrogus jemlichus	HEJE	Himalyan tahr
	Naemorhedus goral	NEGO	Goral
	Capricornis sumatraensis	CASU	Serow
	Procapra picticaudata	PRPI	Tibetan gazelle
	Pantholops hodgsoni	PAHO	Tibetan antelope
	Gazella subguttorosa	GASU	Goitered gazelle
	Camelus bactrianus	CABA	Wild camel
	Moschus chrysogaster	MOCH	Himalayan musk deer
	Moschus sifanicus	MOSI	Chinese musk deer
	Cervus albirostris	CEAL	White–lipped (Thorold's) deer
	Cervus elaphus	CEEL	Red deer
	Cervus elaphus macneili	CEELMA	MacNeil's deer
	Cervus elaphus wallichi	CEELWA	Sikkim stag
	Cervus elaphus hanglu	CEELHA	Hangul or Kashmiri stag
	Sus scrofa	SUSC	Wild pig or boar
	Domestic sheep/goats	LIVES	Small livestock
	Yak, horse, donkey	LIVEL	Large livestock
	Marmota bobak	MABO	Bobak or Himalayan marmot
	Marmota caudata	MACA	Long–tailed marmot
	Ochotona spp.	OC	Pika
	Lepus oiostolus	LEOI	Wooley hare
	Tetraogallus tibetanus	TETI	Tibetan snowcock
	T. himalayensis	TEHI	Himalayan snowcock

Table 5-1. Continued.

Column number	Item	Code	Description
	T. altaicus	TEAL	Altai snowcock
	Alectoris chukor	ALCH	Chukor partridge
	Lerwa lerwa	LELE	Snow partridge
2	Total number in group	Count and record	
3	Distance (m) to group	Record distance from you to animal group	
4	Sex and age composition	Record for each category/class	
5	Search time (hrs/min)	Record total time spent in search of prey animals	
6	Percent area searched	Estimate percent of survey block searched	
7	Number of days sampled	Record total days of search effort	
8	Activity		
	Feeding	FE	Animal is foraging (grazing and/or browsing)
	Resting (up)	RS	Animal is standing and relatively unalert
	Resting (down)	RL	Animal is lying or kneeling
	Alert	AL	Animal is upright and alert
	Walking	WA	Animal is walking (traveling)
	Running (gallop)	GA	Animal is running fast (rapid escape as in a gallop)
	Running (trot)	TR	Animal is running (trotting pace or slower)
9	Rangeland–use		
	None	NON	Area receives no human use
	Seasonal grazing	SGR	Area grazed seasonally by livestock
	Year–round grazing	YRG	Area grazed throughout the year by livestock
	Other	OTH	Other type of land–use (describe)

Table 5-1. Continued.

Column number	Item	Code	Description
10	Habitat type		
	Barren	BAR	Less than 10% of the ground has vegetation cover
	Grassland	GRA	Dominant vegetation is grassland
	Shrubland	SHR	Dominant vegetation consists of shrubs
	Woodland	WOO	Dominated by open trees and savanna
	Forest	FOR	Tree cover exceeds 30%
	Other	OTH	Other habitat type such as field (describe)
	Vegetation type	in–country	Use standard classification developed by acknowledged experts and provide codes to SLIMS node
11	Landform ruggedness		
	Cliff	CLF	Terrain at site is very precipitous (slope more than 50°)
	Very broken	VBR	Terrain heavily broken by cliffs, rocky outcrops, ravines, and gullies
	Moderately broken	MBR	Terrain moderately broken by irregular slopes, rocky outcrops, and gullies
	Rolling	ROL	Terrain has a relatively smooth land surface (e.g., rolling hills or alluvial fan)
	Flat	FLA	Terrain forms a level surface (e.g., plain)
12	Dominant topographic feature		
	Cliff	CLF	Terrain at site is very precipitous (slope more than 50°)
	Ridgeline	RID	Narrow crest of land sloping down on either side
	Hill–slope	HIL	Side or slope of a hill
	Valley floor	VAL	Valley floor of adjacent slope

Table 5-1. Continued.

Column number	Item	Code	Description
	Basin or bowl	BOW	Bowl–like depression
	Stream bed or drainage	STR	Site with seasonal or permanent water flowing through it
	Boulder field	BOU	Outcropping of large boulders
	Talus or scree slope	TAL	Accumulation of rocks and pebbles at base of a steep slope
	Rockfall or landslide	ROC	The mass of rocks at the base of a cliff
	Bluff	BLU	Steep slope bordering a stream or river
	Terrace	TER	Level raised area bordering a stream or river
	Glacier	GLA	Permanent ice field
13	Position on slope (divide mountain slope into equal thirds and classify as one of the following):		
	Upper third	U	Animal located in upper portion of slope, near ridgeline
	Middle third	M	Animal located in middle portion of slope
	Lower third	L	Animal located near bottom of slope, or in the valley
14	Elevation (m) (take from an altimeter or reliable topographic map)		
15	Slope (degrees) (take from clinometer)		
16	Aspect (degrees) (take from compass)		
17	Distance to selected features (estimate the distance to the nearest of the following selected features. Select one, or if more are listed, rank them in order. Identify the item selected by writing its corresponding code after the estimated distance. All distances are assumed to be in meters unless otherwise specified.		

Table 5-1. Concluded.

Column number	Item	Code	Description
	Escape cover	CLF	Cliff
		GUL	Gully
		RID	Ridgeline
		TAL	Talus, scree
		ROC	Rockfall or landslide
		BLU	Riverine bluff
		BOU	Boulder field
	Other landform type (same codes as above)		
	Other dominant topographic feature. See Column 12 above for codes.		
	Human habitation	VIL	Village
		TEN	Nomads camp
		TOW	Town or large settlement
		HER	Herder's corral
	Road	R1	All–season road
		R2	Seasonal road
		R3	Faint track
	Livestock	GOAT	Goat
		SHEP	Sheep
		YAK	Yak
		CRO	Cattle cross–breed
		CAT	Pure cattle breed
		HOR	Horse
		DON	Donkey
	Water	RIV	River or stream
		SPR	Spring or seep
		PON	Pond
		LAK	Lake

Record any other pertinent information in a field notebook. To make informed judgments regarding the distinctiveness of herds seen in different parts of the same search block on the same day or over different days, include information on how far apart each group is from one another, the sex and age of each individual in the group, and the direction in which they appear to be moving with respect to other groups observed (see below). Note any distinctive individuals, such as those missing a horn or displaying a misshapen horn.

Estimate the search effort and proportion of a search site actually sampled. The observer should continue searching as long as it takes to carefully scan the area at least two or three times before moving to the next observation site or search site. Record the total amount of time spent searching for animals in each search site. When visiting a vantage point, estimate the approximate proportion of land–surface area that is hidden from view by trees, gullies, small ridges or rocky outcrops, because animals could be easily hidden in such places and remain undetected. Use a topographic map to help make estimates of the proportion of the search site that is visible to the observer, to the nearest 10 or 20%.

In most cases one will be able to actually see no more than 75% of the landscape within that search area, even if multiple observation points are used. If large parts of a search site are hidden from view, select another vantage point. Two or three observation points will probably be needed to ensure adequate coverage.

Assess habitat. After each animal or group has been counted and classified, record information on selected habitat parameters, as described in Chapter 6, Habitat Assessment Methods.

Analyze Survey Data

Data gathered in the field must be very carefully reviewed and evaluated if reliable total population estimates are to be made. All possible sources of error and bias should be considered. Could the counts be over– or under–estimating the population? Does the observer have specific evidence to suggest that the counts likely reflect the actual situation? Do the numbers vary widely between successive days or among blocks with similar habitat conditions? Could the sample size be too small to adequately reflect conditions within the surveyed area?

These questions are not easy to answer, therefore *transparency* (presenting raw data in the report's appendix) is a good policy, for it permits others to better appreciate how population estimates were derived. Describe in detail the procedure used to extrapolate the total population from individual counts and which counts were used to estimate the minimum number of individuals present in each search site sampled. As already noted, the number of individuals and herds tallied each day can vary. Individuals (especially males and subadults) continually join or leave specific groups, so that herd size and composition of the "same group" vary from day–to–day or even hour–to–hour, especially in highly social ungulates such as blue sheep. Second, one is very unlikely to spot all groups within a particular area. For example, the observer may be faced with the problem of trying to decide whether Herd A (consisting of six females, four lambs, and three males) seen yesterday is the same as Herd C noted today, which consisted of four females, three lambs and three males. The "missing" two females and one lamb may either have been hidden from view, off on their own, or part of another group. There is no sure answer except that (1) the greater the distance between the two groups, the more distinct they are likely to be (for argument's sake, it could be assumed that blue sheep rarely move more than 3 or 4 km between two consecutive days); and (2) the more time has passed, the harder it is to make any decision regarding their distinctiveness. Identification of individuals possessing a crooked horn or lacking one horn allows one to make more informed decisions.

Another option, suggested by Harris (1994a) would be to assign a probability to each sighting, where a probability of 1.0 is given to those two groups that are obviously distinct (for example, they were seen simultaneously or far apart during the same day) at one extreme, to a probability of 0.10, where one cannot say one way or the other whether they are unique groups or individuals. Rather complex mathematical computations are required to make efficient use of such data (namely to develop frequency distributions, point estimates, and confidence intervals), so application of this method will depend upon the observer's knowledge, inclination, and access to computers. Those interested in this level of detail should read Harris's paper and use the software he has developed.

Report Survey Results

The following information should be summarized in tabular form and included in the report or attached appendices:

(a) Number of herds sighted each day and number of individuals in each herd for each search block and/or search site.

(b) Number of days each search block and/or search site was sampled and daily search effort (person–hours) to nearest 0.5 of an hour.

(c) Total number of individuals and herds tallied (all blocks combined).

(d) Average, minimum, and maximum number of herds and animals (all blocks combined).

(e) The minimum number of individuals, as derived by totaling all individuals and herds judged to be unique on the basis of their sex and age composition, recognizable individuals, and spacing with respect to one another.

Box 5–2 suggests report headings and content. Be sure to include photographs showing typical terrain conditions, and a map indicating where censuses were conducted, as well as literature citations and the names of persons undertaking field work.

Box 5-2. Large prey abundance survey report content and headings.

Heading	Content
Title	Title, with the name, affiliation, and address of each author
Introduction	Background information (study species, existing information, data gaps)
Objectives	Primary objectives of the survey
Study area	Description of location, physical features, human population, activities and land–uses, climate, vegetation and habitat types present in the survey area
Methods	Description of methods and study approach employed, including search blocks, and sampling schedule
Results	
Counts	Summary of sightings according to search block
Habitat evaluation	Summary of habitat features associated with animal and herd sightings, habitat(s) in the area surveyed
Major threats	Major threats to ungulate species surveyed
Management issues	Description of the major management issues, including information from interviews of local people
Recommendations	Recommendations for protection and management of large prey species (include qualitative information on small or supplementary prey species such as marmot)
References	Literature cited
Appendices	Persons contacted and interviewed for information, supporting tables, figures, and maps of search blocks/search sites

Copies of the counts by census block, search site, and day (Form No. 3) should be forwarded to the country SLIMS node so that detailed information can be entered into the database (under the proviso that no information will be released to other parties without the author's specific agreement).

Additional Comments

To minimize bias in the survey data, consider the following items:

1. Consistency in applying field methodology is critical. Always set the ground rules (methods) for the count and make sure that everyone involved collects data consistently.

2. Try to sample relatively homogeneous habitat conditions within a single sampling unit. For example, do not include a forest and a grassland in the same census unit, unless the forest is very small and one can see into it reasonably well.

3. Always give thought to the method that may be best, and try to imagine where the source of errors might lie.

4. The report should include details of the methodology and approach employed, including the amount of effort (e.g., number of days, miles driven or walked, hours scanned, etc.) devoted to it, as well as the size (in square kilometers) of each area sampled.

5. Indicate on a map which areas were sampled, with the dates.

6. Train and encourage objectivity. Encourage staff to report census numbers accurately; untrained staff tend to inflate numbers, thinking larger numbers will please senior staff.

Chapter Six – Habitat Assessment Methods

Purpose and Background

Besides determining which wildlife species occur in a particular area and roughly how many there are, wildlife managers also need to assess the kind and quality of habitat available. To attain optimum population size, animals require an adequate supply of food, cover, and water as well as seclusion or protection from threats such as natural predators, excessive hunting by humans, and excessive transmission of disease. Usually, ungulate population size and productivity are limited by only a few factors such as hunting, access to minimally disturbed winter pasturage and lambing areas, and good–quality forage for nursing females. Such “bottlenecks” are viewed as limiting factors by ecologists.

No species can maintain unlimited population growth. Managers must maintain wildlife numbers within the carrying capacity of the habitat to maximize productivity and better ensure sustainability. However, wildlife management in Central Asia is in its infancy, and knowledge on the most important limiting factors is usually lacking. Therefore, the most prudent strategy at this stage might be to gather as much data as possible on patterns of habitat use, through literature reviews and interviews of scientists as well as knowledgeable local pastoralists or hunters who co–exist with the species in question. However, one should always view data from laymen with some circumspection until carefully designed scientific studies can validate observations. Furthermore, conditions in one area may differ from those faced by the species elsewhere in its range. This difference in conditions is especially true of mountain ungulates that have become adapted to localized habitat and climatic conditions.

By gathering basic information on habitat conditions present at each location (site) where a particular species is observed, field biologists can develop a “profile” of that species’ habitat requirements or preferences. This profile can assist in determining why a particular species does not occur where it should, or why its numbers are lower than anticipated. Comparisons of habitat conditions among sites supporting dense populations and sites with sparse populations also offer insight into potential species management requirements. Habitat in this context includes such disturbance factors as hunting, livestock grazing and other human activities. The handbook offers suggestions for specific habitat parameters that could be noted each time a sighting is made.

Habitat Assessment

Objectives

1. Characterize habitat conditions in survey area.

2. Identify critical wildlife sites and habitats.

3. Prepare species and habitat profiles.

Outputs

1. Description of vegetation and habitat types within survey areas.

2. Assessment of limiting factors and habitat constraints.

3. Map of critical birthing sites, wintering areas, and movement corridors.

4. Black and white photographs of the survey area indicating typical habitats.

5. Recommendations for species and habitat protection and management.

Methods

Habitat assessments are undertaken concurrently with Prey Species Abundance Surveys.

Identify Biotic Communities and Landform Types

Wildlife habitat should be described at three levels: (1) General – The five general habitat types used to describe snow leopard habitat are: barren, grassland, shrubland, woodland, and forest (Table 5–1); (2) Detailed (based on life–form, dominant species and successional stage); and (3) Key Features (see below).

A standard system for classifying the biotic communities, including vegetation types, is needed as a basis for delineating wildlife habitat types. These can be very specific (e.g., *Stipa purpurea* grassland, *Juniperus recurva* shrubland, *Abies spectabilis* forest) or very general such as "alpine meadow", "desert scrubland" or "deciduous forest land". Most vegetation classification systems are based on an hierarchical classification involving (a) life–form type (for example, forest, shrubland, desert, or wetland community); and (b) the most abundant and/or dominant plant species present (usually one or two and rarely more than five). Typically these are plants that form the canopy or overhead cover, as well as the successional stage of the community (Cooperrider et al. 1986). Other elements used in distinguishing between features are elevation, slope and aspect, and land–use type.

Examples of vegetation and habitat classifications are included in this handbook, but these classifications will need modifications based on local conditions. Therefore, consult local scientists or nationally recognized community ecologists to determine which are the most widely recognized and accepted classification systems, and adapt these systems accordingly. Some countries publish vegetation maps at scales of 1:1,000,000 or less.

Examples of key features are cliffs, caves or rock–overhangs, streams, water holes, salt licks, birthing sites, and related landscape or terrain features that play a critical role in the lives of snow leopards and prey animals. Snow leopard, ibex, and blue sheep require cover to which they can escape when threatened by man or predators. Other species, such as Tibetan antelope, may have special requirements for birthing areas. In areas of high snowfall, blue sheep and ibex seek gentle slopes with southerly aspects, which are less avalanche prone and from which snow melts more rapidly, ensuring easier access to forage.

Schedule and Prepare for the Survey

Obtain vegetation maps prior to visiting the field so that their accuracy can be assessed through groundtruthing. A long–term objective should involve mapping major vegetation and habitat types, particularly within protected areas. Large format camera photographs (NASA), which can be enlarged to a scale of 1:100,000, provide fairly inexpensive images useful to initially identify potential snow leopard or prey habitat. Landsat imagery has been used to map land–cover types and identify wildlife habitat in the Hemis National Park in India. Although "Landsat Thematic Mapper" remotely sensed images are expensive, they have proven successful for identifying sedge meadow communities, an important habitat of wild yak in the Wild Yak Valley of Qinghai Province (Miller, personal communication). Digital coverages may also prove helpful in identifying, classifying, and mapping habitat for key snow leopard prey species such as blue sheep and argali.

Similarly, topographic maps and black–and–white aerial photographs aid in interpreting and mapping terrain types. Considerable supplementary information can be derived if the resulting cover associations are overlain on a topographic map showing elevation, slope and aspect, or on a geological or soil map. Contours provide an index of land–surface ruggedness: the closer and more sinuous the contours, the more the land is broken. This topographic information is informative, for snow leopards prefer habitat that is well broken by cliffs, rocky outcrops, and drainages (Jackson and Ahlborn 1984), while blue sheep are usually found near cliffs or broken slopes but prefer to forage on smoothly surfaced alpine meadows or valley slopes. Many plant types are associated with specific topographic aspects (e.g., birch on more mesic northerly slopes) or in association with special soil and rock substrate (chemical) conditions (e.g., cypress forests are usually found on limestone soils). Once terrain, habitat, or vegetation units have been mapped, compute the total area of each type available or match ungulate sightings with relevant vegetation cover types. If sufficient information has been accumulated, base maps could be digitized into a Geographic Information System (GIS) for subsequent analyses (Maguire et al. 1991; Hunter and Jackson 1995).

Conduct the Field Survey

Habitat use information is gathered by noting selected features (such as elevation, slope, aspect, habitat type, and terrain features) at each of the field sites where wildlife species of interest are seen.

Habitat availability data is obtained by recording the same variables at a large sampling of random points located throughout the study area. When gathering habitat use information, record habitat features for an unbiased series of locations at which individuals were "first sighted". The larger the sample size the better, especially if habitats are diverse, the landscape is heterogeneous, and if habitat use differs according to sex, age, and social unit. When gathering habitat availability information, a topographic map is obtained for the study area, and a table of random numbers is used to derive a series of X,Y coordinate pairs; these coordinates are plotted on the map, and the site is visited and characterized.

Use Form 3 to record use or availability information. Use the space provided under the columns titled "Block" to note the observation number, or the random site number and X,Y coordinates. Box 6–1 contains a summary of information recorded for each sighting.

Because individuals of a herd may be very spread out, apply the following rules:

1. Use the geographic center of the herd for locations or the feature exhibited by most individuals. Try to be consistent in this regard.

2. List the activity exhibited by a majority of the herd at the time of first sighting (obviously animals are likely to flee as soon as they are approached).

3. If possible, give only one item for each variable. If a decision cannot be made among the various options, then rank these starting with the one that most closely fits the observation.

4. If the item is not known, use the symbol "N/K" (or equivalent) for "not known".

Observers should be sure to include all pertinent observations on the form or in their field notebook. In addition, information should be collected and recorded in a consistent manner and gathered in different areas over each season, because many species may use habitats differently in winter than in summer.

Identify key wildlife areas or sites of critical importance. As noted, an adequate prey base must exist if an area is to support snow leopards on a permanent basis. Therefore, special effort should be devoted to identifying and mapping the best wildlife sites and habitat within the survey area. Support this information with an assessment of factors promoting species abundance and richness, and factors likely attributing to a particular species' scarcity or absence.

Box 6-1. Summary of information recorded for each sighting. Codes are given in Table 5–1.

Item No.	Description
1	Wildlife species
2	Number in the group and the dominant activity (e.g., feeding, resting, running, or walking; alternatively, specify number for each type of activity)
3	Distance of animals from observer (in meters) (Leave blank for a random point characterization)
4	Sex and age composition (see Appendix C)
11	Elevation (in meters) and position on slope (upper one–third, middle one–third, or lower one–third, where the mountain slope within the immediate vicinity is divided into equal thirds)
12	Dominant slope of land (to nearest 5 degrees)
13	Dominant aspect (within nearest 5 degrees)
9	Rangeland and land–use types
10	Habitat and vegetation types
11	Landform type
12	Dominant topographic feature present
17	Distance (in meters) to nearest feature (if known), including: – cliff – other escape cover (identify and name) – other landform feature – other topographic feature – water source – salt lick – other habitat type or edge (identify and name) – human habitation or settlement (name) – road (name) – livestock (kind and number in herd) – blank spaces provided for other features of interest

This task can be accomplished by describing the major wildlife habitats present, their distribution and relative abundance; locating and mapping the distribution of key wildlife sites, such as birthing or lambing areas, wintering areas, salt licks, and water holes; identifying important wildlife movement corridors and staging areas; gathering information on the availability and distribution of escape and hiding cover in relation to foraging areas; and characterizing human activities in the area, especially with reference to livestock grazing and pasture management, predation of livestock, hunting and poaching activities, impacts from roads, mines, waterways and other development projects; deforestation, and agriculture.

Use the resulting information to develop a checklist of factors affecting wildlife and to map potentially sensitive sites where management initiatives should be addressed. The information also serves as the basis for developing species and habitat profiles.

Interview local residents for information on human activities. Useful information can be gathered by interviewing the local people to determine which sites are used for wintering and lambing and where wildlife was observed during times of special stress, such as "the worst winter or drought in the last decade or two". Which sites receive the least amount of snow accumulation (which precludes or limits access to forage) or are most protected from the elements (presenting animals with less thermal stress)? Are wildlife–rich areas being adversely affected by livestock grazing, and are herders suffering from depredation of livestock by snow leopards or wolves? If so, where are the depredation "hotspots"? Try to correlate wildlife abundance with the number of livestock using the same area, and record whether such use is seasonal or year–round. How close are different wildlife species found from human settlements? At what distance do animals flee from an approaching vehicle, as opposed to a person walking or riding a horse? What is the extent of hunting in the area and who is primarily responsible? Is hunting limited to a particular season or time of year? Does one part of the survey area receive significantly heavier pressure than another? The main sources of information for answering these and other questions are local people, with skulls and bones serving as confirmation of hunting or significant winter die–off. Collect skulls and lower jaws to provide the basis for developing standardized age classes based on tooth eruption and wear.

Is hunting pervasive, and if so, on what scale? While subsistence hunting rarely leads to elimination of a species, commercial trophy hunting (musk of the musk deer or the wool of the Tibetan antelope) or meat hunting (e.g., wild yak) can eliminate wildlife in the area within very few years.

Another question to explore is whether local people would be willing to serve as game guards if they benefitted from the wildlife through controlled hunting programs or wildlife viewing by tourists. Which ethnic groups or settlements would serve as the most effective guardians of the wildlife? What cultural values could be used to encourage wildlife conservation by local people?

Analyze Survey Data

Prepare generalized habitat and vegetation maps. A long–term goal involves the preparation of habitat and vegetation maps (including sketch maps illustrating key wildlife sites), which permit spatial analyses of such important elements as *edge*, *juxtaposition*, and *habitat heterogeneity*. While detailed topographic maps may not be available for the study area, even large–scale generalized maps can be of great value in conveying information. Each wildlife or protected areas agency should, therefore, attempt to develop base maps for areas of interest at a scale of 1:100,000. An archival series could be maintained to record information gathered over successive years to better delineate trends and shifts in habitat use patterns, as well as the management of conflict areas.

Vegetation and habitat mapping is a separate project, requiring trained personnel, specialized equipment and supplies (e.g., aerial photographs, satellite images, stereoscopic mapping equipment). The reader is referred to Schemnitz (1980), Conant et al. (1983), and Cooperrider et al. (1986) for further information.

Prepare species and habitat profiles. One of the primary goals of SLIMS is to encourage the dissemination of information about the snow leopard, its prey, and habitat. The preparation of species–based natural history profiles for each part of the snow leopard's range would be most helpful to this goal (Box 6–2). Accurate and comprehensive profiles permit resource managers to develop region–wide management plans that are sensitive to the needs of all large mammals.

The first step involves summarizing the field data collected to date and then supplementing it with information accruing from an in–depth review of the literature as well as discussions with experts. The following headings should be considered in preparing profiles for key prey species or other important wildlife (e.g., Threatened, Endangered, First or Second Class, and economically important species):

(a) Biome and ecosystem used.

(b) Legal status.

(c) Status in the wild (e.g., population density or size and extent to which it is at risk of decline) and distribution pattern (for example, a range map).

(d) Habitat requirements (e.g., vegetation types, landscape, or landforms most frequently used).

(e) Breeding sites and habitat needs.

(f) Predator and security escape cover requirements.

(g) Shelter for escaping adverse weather conditions.

Box 6-2. Species and habitat management profile.

Suggested Guidelines

Species (common, local, and scientific names)

Taxonomic classification: Not essential, but highlights relationships among different species in a particular area (Order, Family, Subfamily, Genus, Species, Subspecies).

Physical features: Distinguishing characteristics for field identification, including size (dimensions such as head–body length, shoulder height, tail length, etc.) and shape, pelage coloration, sexual dimorphorism, vocalization, key physical adaptations for mode of life.

Biome and ecosystem: In order, biogeographic realm (e.g., Palaearctic region); biogeographic province (according to IUCN classification prepared by Udvardy [1975]; within snow leopard range, these are Himalayan Highlands, Tibetan, Hindu–Kush Highlands, Pamir–Tian Shan Highlands, Altai Highlands, Szechwan Highlands, Mongolian–Manchurian Steppe and Takla–Makan–Gobi Desert); life or ecological zone (tropical to alpine) with elevational range; any other biological/climatic descriptors identifying ecosystem with which the species is associated (e.g., juniper scrub, *Caragana* desert). Note the biological descriptions may overlap with information under the habitat section.

Legal status: List legal status and the degree of protection afforded under existing regulations, as well as IUCN threatened species categories from the Red Data Book (i.e., one of the following categories, extinct, endangered, vulnerable, rare, indeterminate, insufficiently known, threatened, commercially threatened).

Distribution and population status: Describe the species range at two levels – global population and country–specific distribution pattern. List current status of in-country populations in terms of their size and trend (i.e., total estimated number of animals, population estimates for specific subregions in country, and whether the population is known or thought to be increasing, declining or remaining relatively stable). If this information is known, give an estimate for density (specify if based on potential or occupied habitat). Comment on the reliability of the information, or lack thereof.

Social organization, herd composition, and reproduction: Identify the pattern of social organization. List one or more of the following options: solitary or gregarious; territorial or non–territorial; sedentary or migratory; monogamous or polygynous reproduction. Provide information on group or herd size (average, smallest, and largest herds observed), and whether these vary with season.

Where available, provide information on sex and age composition of sub–populations including sex ratio; young/female ratio (number of lambs/100 adult female), adult male/female ratio, and other detailed life history statistics indicative of mortality and recruitment rates.

Box 6–2. Concluded.

Identify those habitat factors most closely associated with presence–absence and high population densities. Try to be as specific as possible.

Birthing areas and other critical habitat: Describe habitat conditions essential for successful reproduction and over–wintering, as well as various environmental features deemed to significantly limit distribution or population size (e.g., dependency on specific plant community successional stages, dietary specializations, proximity to nearest escape cover, dependency on sources of drinking water, salt and minerals, thermal cover). What is the optimal mix or juxtaposition of key habitats (amount of edge, minimum size of each habitat "block")?

Food habits: List major food items and degree of specialization (plants and animal; generalist or specialist), noting any seasonal differences in use. If a herbivore, identify whether a browser, grazer, or mixed forager. If a carnivore, are its annual food requirements known? (type and number of prey required to sustain one breeding adult).

Activity, movement pattern, and home range: Describe daily activity pattern, noting periods of maximum and minimum activity and seasonal variations (if any). Describe daily and seasonal (including elevational) movement patterns (ranging), and how the animal finds its food, resting sites, etc. If known, note home range size (square kilometers, average, maximum and minimum) and the extent to which ranges overlap among breeding pairs or dominant males (territoriality). What antipredator behaviors are exhibited (alarm calls, concealment and escape tactics, self defense)?

Limiting factors: List the major threats to the population, such as loss and fragmentation of habitat, poaching, excessive harvesting, disease, catastrophic events (drought, wild fire), etc.

Conservation and management requirements: List the most important management actions to enhance and safeguard populations of the species in question. These could include, for example, establishment of additional protected areas, buffer zones, and special management areas along key corridors, anti–poaching programs, habitat enhancement and sustainable utilization (income–generating) programs for local communities.

Specify actions required to establish population status and distribution, and to monitor trends in population levels (e.g., annual herd censuses in key areas, sex and age composition counts for constructing life tables, lamb counts to establish recruitment rates in different areas).

Information gaps: Identify information gaps and research priorities.

References: List major sources of information, including unpublished departmental reports.

Name and date: Name of person(s) preparing the profile with date.

Send a copy of your profile to the local SLIMS office and ISLT.

(h) Seasonal movements and winter or summer habitat(s).

(I) Food items and important foraging habitat.

(j) Type of social organization (solitary or a herd unit).

(k) Approximate home range area (useful for estimating the amount of land area required to support a minimum viable population or the habitat requirements of an individual).

(l) Major threats (e.g., hunting, livestock grazing, loss or modification of habitat, other environmental changes).

(m) Conservation requirements (e.g., protected areas coverage, hunting legislation, management actions).

Additional species information useful in establishing management programs or developing sustainable uses includes data on population dynamics (for example, the optimal sex and age structure or the number of animals that can be harvested annually without depleting the population or disrupting genetic variability). Information on behavioral patterns is also useful (for example, how the species reacts when livestock graze in the same area).

Habitat profiles summarize information on distinct habitats or ecosystems (for example, a grassland or forest association) found within a particular geographic area, a biogeographic province, or biotic region within the snow leopard's range. Besides offering plant and animal species lists, information is provided on such topics as successional and climax patterns, wildlife niches and habitat relationships, trophic relationships, edge and ecotonal effects, determinants of carrying capacity, competition, symbiotic and parasitic relations, and other aspects of ecosystem dynamics.

Once drafted, species and habitat profiles should be sent to experts for review and comment. Revised versions can then be made available to resource managers and others.

Report Survey Results

Information on habitat is integrated into the prey species report described in Chapter 5. At a minimum, the report should contain: a list of the landform, habitat and vegetation types found in the area surveyed; preliminary *Habitat Profiles* for selected species found in the study area; the locations (include map) and a description of significant wildlife areas, such as critical lambing sites and wintering areas; the locations and descriptions of areas considered by local people to be depredation hotspots or sites where conflict with livestock and humans is most significant; maps of habitats or vegetation types; tables showing the average value (continuous variables) or percent distribution (categorical variables) for the habitat features measured; andrecommendations for which areas that are most in need of protection and management intervention (see Chapter 7).

One goal of SLIMS and this handbook lies in encouraging long–term research into distribution, population trends, habitat use, and management of the snow leopard and its prey. Ideally, one needs to know which habitats a particular species prefers, which are avoided, and what factors contribute most to habitat selection. This habitat use can be determined, in part, by statistically comparing habitat samples from herd sightings with those available to the same population, to test the hypothesis that each habitat is used in proportion to its availability (for example, see Neu et al. 1974). This information helps establish whether animals use some habitats more than others. The proportion of each habitat type available can be derived by measuring the total area of each, using habitat maps, aerial photographs, or through random sampling in the field. This habitat analysis should be complemented with basic natural history and food habits studies, to identify preferred forage species, dietary constraints, and other factors. Such knowledge enables a land manager to decide whether to focus limited manpower and funding on improving forage conditions, on enhancing wintering areas, or on seeking to reduce livestock grazing within selected areas.

Chapter Seven - Conservation and Management

Introduction

The snow leopard is threatened by depletion of its prey base, the loss and modification of its habitat, hunting for its prized pelt (which may fetch 60,000 U.S. dollars or more on the black market when fashioned into a coat for wealthy Westerners), sale of its bones which are highly valued in the Chinese medicinal trade, or simply retribution at the hands of angry shepherds who lose valuable livestock to hungry cats (Schaller 1977; Schaller et al. 1987; Cai et al. 1989; Fox 1989; Harris 1994b; Jackson et al. 1994a,b). With the depletion of its prey species – blue sheep, ibex, argali, marmots, and other small animals – the snow leopard is increasingly forced to subsist on domestic animals, thereby guaranteeing the predator a short life.

More is at stake than just dwindling wildlife. Central Asia's mountains are home to some of the world's most unique human cultures and livelihoods, now threatened by deforestation, marginal agriculture and overgrazing of livestock, and economic inflation. Just as the snow leopard is a striking indicator for ecological balance on the world's loftiest highlands, so it could also serve as an environmental ambassador for international cooperation.

Animal husbandry and pastoralism, mining, timber harvesting, and oil exploration are economic activities of prime importance that occur in high mountain areas. Such activities may adversely affect wildlife through loss of habitat, illegal hunting, and other disturbances. Road–building can have a significant indirect impact, particularly where previously inaccessible terrain is involved. New roads permit easy access by settlers, miners, or pastoralists, but they are also essential to economic development. Where roads provide seasonal or year–round access, the potential for commercial hunting of wildlife is greatly increased unless the authorities take stringent measures. As experience has shown in the case of North America's bison and passenger pigeon, sustained commercial hunting may rapidly lead to the species' extinction.

Protected areas can support only a small part of the world's wild snow leopard population because most protected areas are small and essentially isolated from one another. Habitat fragmentation continues to deplete populations and gene–pool resources. Primary productivity in mountainous areas may be severely limited by the harsh climate, so that herders also require large areas for grazing their animals and for obtaining natural resources vital to human subsistence. The coexistence of livestock and wildlife presents land managers with an array of problems and opportunities central to wildlife conservation in the snow leopard's range, because pastoralism is the dominant human activity over large regions. The multiple use concept provides the best opportunity to integrate wildlife conservation with range–livestock development because wildlife is generally of secondary consideration on most rangelands (Miller and Jackson, in press). Range management practices can significantly affect wildlife numbers and diversity because wildlife populations are strongly regulated by the availability of food, water, and cover. For example, livestock can affect habitat directly by removing or trampling vegetation and by causing shifts in a plant community's species composition and cover. Heavy grazing usually reduces plant species diversity; as range condition declines and plant diversity decreases, the nutritive value of forage for wild ungulates also declines. Basic research is urgently needed to identify key wildlife and livestock forage plants, and to assess range plant composition and productivity under varying intensities, and kinds of livestock and wildlife use. Many mountain areas are seriously overgrazed, depleting resources vital to human survival.

Disturbance due to the presence of people and uncontrolled wildlife hunting should be an important concern for managers. For example, while blue sheep are reasonably tolerant of unattended livestock grazing nearby, they generally avoid permanent or temporary human settlements. Disturbance may be most critical during the months of lambing and during severe winters if disturbance limits ungulate access to critical alternative areas, often in lower valleys where permanent settlements and year–round livestock grazing are more likely to be found.

On the other hand, wildlife may adversely affect domestic livestock. For example, wild ungulates may introduce and transmit disease, while predators such as wolf and snow leopard may kill significant numbers of sheep or goats. Rodents and rabbits compete for the same forage, especially during periods of peak populations. Marmots may denude the area of vegetation around their burrows. However, positive impacts of these small mammals include aeration of soil, mineral cycling, and soil mixing, all actions that tend to speed up the process of soil formation. Game–birds may play a significant role in keeping insect populations under control.

Livestock killing is the most significant people–wildlife conflict. Loss of livestock places the greatest economic burden on herders, who may have no alternative income, and thus depend heavily on their animals. Furthermore, many families are poor, with little or no monetary reserves to replace lost animals. Loss rates vary widely, being highest in the remote areas that support higher densities of predators or in areas where domestic animals are not well–guarded by their owners. Circumstantial evidence suggests that depredation increases in places where native ungulate populations have been depleted. Schaller et al. (1988) have noted that marmot may limit snow leopard dependence on livestock during summer months.

Besides encroachment and conflicting demands, other threats to mountainous protected areas include poorly sited road construction and resulting erosion, degraded water quality (with resultant human disease and mortality), deforestation, and uncontrolled burning of rangelands.

SEVEN – CONSERVATION AND MANAGEMENT

Wildlife survival rates can be enhanced by improving habitat and the availability of essential natural resources. For example, snow leopards and other predators such as the wolf are less likely to kill livestock if they have an adequate supply of native prey species available to them. Examples of relatively simple habitat manipulations include controlling the numbers of livestock using the same area or excluding them during certain times of year. Managers of protected areas could negotiate with local pastoralists to avoid certain areas during the lambing season and to rotate their use of summer pastures to ensure that adequate forage is left for wildlife using such sites during the winter. Rather than using limited funds to pay compensation, it would be better to encourage herders to guard their animals more stringently and if possible, not to graze livestock in known depredation hotspots. To achieve this goal, they could be offered incentives such as free veterinary care or assistance in getting livestock products to more profitable markets (which are frequently located far away). Supplementary water supplies could be provided in arid areas, while natural successional shifts in vegetation could be encouraged to enhance cover for wildlife. All protected area managers need to conduct periodic field surveys to monitor habitat changes, to accumulate baseline information, and to remedy habitat imbalances. High priority must be placed on identifying the basic habitat requirements for all rare or key wildlife species inhabiting the area.

Governments are finding it increasingly difficult to protect their countries' wild plants and animals as these become more scarce and as pressures mount from an increasing human population. Nevertheless, these natural resources are invaluable to all mankind. If they are to be available for future generations, the present generation has the critical responsibility of ensuring that their use is sustainable. There are many tools available, including the enactment and enforcement of special laws, education of the public, provision of incentives (such as development assistance in exchange for conservation by local people), and the establishment and protection of parks and nature reserves in especially rich habitats.

While many wildlife and protected area managers are well aware of these and other management issues, their ability to address them is hampered by lack of financial resources, equipment, transportation, and access to many remote areas, and poorly trained staff. The involvement of local people, however, is essential for any successful conservation in central Asia (Figure 7–1). Project Snow Leopard attempts to address some of these issues by providing standard methods and supplementing available resources in countries with wild populations of snow leopards. The following sections are suggested approaches and guidelines for controlling poaching, evaluating protected area coverage and protected area management.

Control Poaching of Snow Leopards and Prey

Objectives

1. Develop and implement plans for controlling illegal hunting of snow leopards and important prey species.

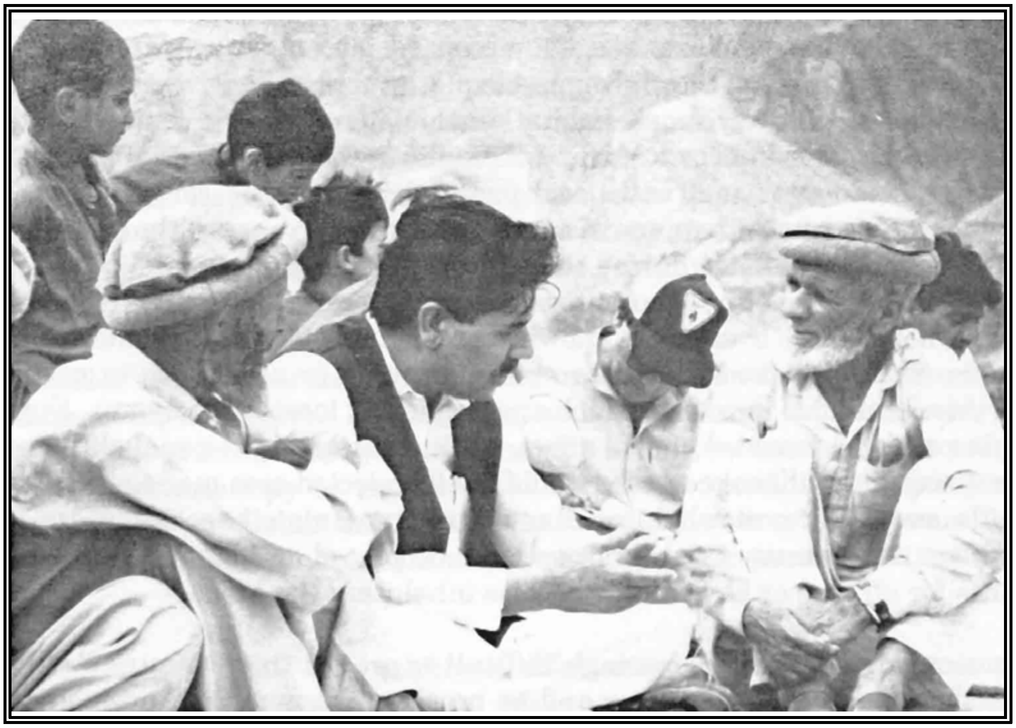

Figure 7–1. Meeting with local inhabitants is an important step toward improving snow leopard conservation (Photo: Don Hunter).

2. Reverse any declining wildlife populations, especially in and around national parks, reserves, and other protected areas.

Outputs

1. Wildlife protection laws reviewed and enacted (including ratification of CITES).

2. Anti–poaching patrols mounted.

3. Illegal trade in wildlife greatly reduced or terminated.

4. Progress reports submitted to responsible government agencies and SLIMS.

Suggested Activities and Actions

Strengthen wildlife protection laws. Most countries have laws to protect and conserve wildlife, but these laws are often in need of revision and/or expansion. Legal review of existing legislation should be undertaken as soon as possible to confirm the adequacy of rules and regulations for species protection.

Hunting without proper permits, killing endangered or threatened species, and habitat degradation due to illegal dumping of industrial wastes must be dealt with firmly. To restore the natural balance, bounty programs (cash rewards for turning in furs) should be discontinued or strictly controlled (Jackson 1990). The use of leghold and other damaging or inhumane traps for controlling depredators should be examined for all species including wolves, foxes, or endangered species such as snow leopard and lynx. In cases where the agency lacks authority to arrest offenders, it will need to secure assistance from law–enforcement agencies. If laws are inadequate, they should be amended. Protected area management must maintain the national interest above that of individuals or local communities.

Laws are only a means to an end, and no amount of policing can prevent infringements if people find the rewards of breaking the law are greater than the penalty imposed on them for doing so. Penalties should be at least five times the market value of the animal product illegally traded.

It is cheaper to manage a resource wisely than to pay for its restoration after it has been depleted to near extinction, thus the truism, "the prevention is better than the cure." Because over–use of resources is a public problem, wildlife managers are urged to build consensus with local communities and to seek their assistance in protecting rare animals, plants, and habitat. Nature education programs are also important for agencies vested with wildlife conservation responsibilities.

For more information on strengthening wildlife protection laws, the reader is referred to Lausche (1980), Lyster (1985), and the relevant chapters in the excellent handbook prepared by the IUCN (MacKinnon et al. 1986).

Control trade in wildlife products. According to recent reports issued by the Secretariat of CITES (Convention on Trade in Endangered Species of Wild Fauna and Flora, promulgated in 1973), the IUCN Cat Specialist Group, and other organizations, trade in the bones of tigers and other larger cats such as snow leopards and lynx has so increased that it now threatens their very existence. Many cities in south and southeast Asia have thriving curio or medicinal markets selling everything from antelope horns to tiger penises and bear claws, plus snow leopard pelts and bones. Despite the presence of national and international laws controlling or prohibiting trade, consumption is rapidly exceeding the capacity of wild populations to reproduce, with disastrous implications.

Governments must assume responsibility for preventing international trade under the provisions of CITES, to which many of these countries are signatory. If they are not already members, they should be encouraged to join. National laws should also be amended to deal with trade in wildlife parts that contribute to loss of wildlife resources or encourages animal cruelty.

Specific actions for controlling the trade in snow leopard pelts (furs) and bones are provided in Box 7–1.

Box 7–1. Controlling trade in snow leopard furs and bones.

- Enact and enforce strong wildlife protection laws with penalties that exceed the rewards of black market trading.
- Ban public sale of products and police market places.
- Establish vehicular check–posts at borders and along known or suspected trade routes. (*Vary the time and location so that they are harder to circumvent.*)
- Educate the general public, tourists, and government officials on the impacts of illegal trading, and post warnings at airports and other staging points.
- Mount anti–poaching patrols, especially in and near parks and protected areas.
- Offer rewards for information leading to conviction of poachers and persons trading in protected species. (*Honor anonymity of informants so that they need not fear reprisal.*)
- Make agreements with local people to serve as game guards in exchange for economic and community development. (*For example, promote nature tourism in areas where wildlife is protected by local residents.*)

Anti–poaching field patrols. Wildlife conservation starts in the field with a well–trained and disciplined staff, with appropriate opportunities and incentives for advancement, and in–service training. Poor work should not be rewarded in the same way as hard work.

All parks, reserves, and other protected areas need staff who are motivated and willing to regularly tour remote areas. Successful park administrations are characterized by staff whose morale and team spirit is strong and who are properly equipped, disciplined, and well–dressed.

Staff need to be rewarded for work well done, which should be based on the submission of regular, accurate progress and tour reports, as well as the goodwill expressed by local people towards the department. Corruption among park staff must not be tolerated and severe penalties are needed to ensure officials do not illegally sell hunting licenses, especially to foreigners or outsiders. Relations with local communities should be good, even while poachers are being apprehended, and while needed regulations regarding livestock grazing or resources are being promulgated. Where conflicts exist, these should be addressed fairly. Box 7–2 outlines steps in planning anti–poaching patrols.

Evaluate Protected Areas Coverage

Objectives

1. Evaluate protected areas coverage in relation to snow leopard distribution and identify gaps in mountain park and preserve coverage.

2. Locate and design protected areas to maximize protection and mountain species diversity.

Outputs

1. A “gap analysis” indicating priorities and needs for the existing protected areas network.

2. Report describing protected area status, needs, and priorities.

3. Participation in the International Snow Leopard Trust’s Project Snow Leopard.

Background. Snow leopards and their associated mountain fauna and flora (montane biological diversity), are best protected through a network of parks, reserves and other specially managed areas known as protected areas, or PAs. Ideally, such areas protect, to the benefit of all peoples, representative numbers of plants, animals and habitats within a particular country or biogeographic province (Box 7–3).

PAs afford the world, countries and their citizens many ecological, social and economic benefits (McNeely and Miller 1984; MacKinnon et al. 1986; Dixon and Sherman 1990).

Box 7-2. Planning anti–poaching patrols.

- Patrols should consist of at least two persons. (*Mutual support, safety, corroborate evidence.*)
- Patrols should be properly equipped for weather and terrain.
- Patrol staff and game guards should be offered incentives for completing patrols; the rewards for apprehending poachers should be commensurate with the risk involved.
- Patrol visits should be unpredictable. (*Use different routes and schedules from month to month.*)
- Ensure wide–ranging coverage of reserves. (*Patrol all areas, not just boundaries or roads.*)
- Guards should be moved regularly among posts. (*Increases experience and builds stronger team–work.*)
- Patrols should be thoroughly briefed and debriefed. (*Standard field and reporting forms should be provided.*)
- Guards should report on their patrols in writing, by keeping notebooks of field activities and recording biological observations. (*Notebooks, pencils, and binoculars should be provided.*)
- Guards should be armed if poachers have weapons.
- Departmental administrators should develop a program for monitoring the effectiveness of both anti–poaching patrols and the illegal trade in animals or their parts.
- The effectiveness with which remote parks or reserves can be managed depends on the extent to which they are visited and patrolled by staff. While serving as a means of preventing or controlling poaching, field patrols offer much more. They should be used as an opportunity to gather baseline information for management and proper resource use.

Box 7–3. Some benefits of protected areas.

- Stabilize watersheds and hydrological functions.
- Protect soils and enhance nutrient cycles.
- Stabilize regional climate.
- Conserve renewable, harvestable resources.
- Protect genetic resources.
- Preserve breeding stock and species gene pool reservoirs.
- Maintain biological diversity.
- Promote tourism and provide recreational opportunities.
- Provide employment opportunities.
- Provide research and educational opportunities.
- Enhance environmental quality and natural balance.
- Preserve traditional cultural values.
- Encourage regional pride in one's heritage.
- Buffers offer chance for eco–development activities to benefit local communities.

Project Snow Leopard recognizes the importance of protected areas as repositories of biological diversity in Central Asia's high mountain ecosystems (Hunter et al. 1994). Current information on the status of the world's protected areas is often lacking, a key concern of the World Monitoring Centre of the World Conservation Union based in Cambridge, England (Green 1993). With financial and other resources becoming increasingly scarce, all parties must cooperate to the maximum degree possible, consistent with concerns of national pride, autonomy, and independence. Highest priority is given to the establishment of a protected areas' network throughout the 12 countries that host wild populations of snow leopards. To this end, the ISLT seeks to standardize snow leopard surveys and information gathering by offering technical and logistical support for selected protected areas in each country.

Much has been written on the subject of protected area criteria and development. This handbook briefly introduces the subject and is not a manual for protected areas management – except with regard to snow leopards and their prey. Although written with the tropical region in mind, IUCN's publication “Managing Protected Areas in the Tropics” (MacKinnon et al. 1986) offers excellent information on the subject that is equally applicable to the mountain region of Central Asia. Managers should also consult the guidelines developed by IUCN’s Commission on National Parks and Protected Areas specifically for mountain PAs (Poore 1992). The American Association for the Advancement of Science published a book on resource inventory methods (Conant et al. 1983), while Cooperrider et al. (1986) offer a review of wildlife inventory and monitoring techniques; although geared for the United States, its overall approach and principles are applicable to Central Asia. Procedures for preserving biodiversity are summarized by Meffe and Carroll (1994) and Noss and Cooperrider (1994). The references listed in Chapter 8 offer other relevant publications, based on experiences throughout the world.

Suggested Activities and Actions

Assess protected areas coverage. The agencies responsible for reserve establishment and management are urged to conduct an evaluation of the adequacy of protected area coverage within their geographic area to ensure that representative species, communities, and ecosystems within each particular biogeographical province are adequately represented; to identify important gaps in coverage; locate potential candidate sites for poorly represented resources or ecosystems; and assess management needs within existing and proposed PAs.

As the world’s fauna and flora disappear, protection of biological diversity is emphasized. Species richness, or the total number of species within a given area, has been used to identify biological hotspots. While montane areas lack the high number of plants and animals found in the tropics, the importance of preserving as many species as possible is equally valid. The emerging discipline of landscape ecology examines spatial patterns in the landscape (Urban et al. 1987). Recently, computerized geographical information systems (GIS) have been used to assess spatial patterns of species richness, and to identify gaps in coverage (Scott et al. 1987; Davis et al. 1990). In conjunction with satellite imagery, such as Landsat and SPOT, a GIS can provide a very important informational and analytical tool. But computers and sophisticated technology are not essential to identify where protected areas might best be established. Simple field surveys and inventories in which habitats and species are noted, tabulated, classified, and mapped can be equally effective in determining where the most important gaps are. Many biologists view the snow leopard and other large endangered carnivores as useful indicators, arguing that their position at the top of the food chain allows them to serve as an indicator of ecological health and biological diversity: where snow leopard numbers are good, the area may support many other plants and animals.

Only species that occur in the same general habitats as snow leopard would be benefitted, therefore, other indicator species should be used as well to protect the unique fauna and flora of Asia's high mountains.

Criteria for locating and selecting protected areas. Indicator species have been used as a basis for locating and selecting PAs for several reasons (adapted from MacKinnon et al. 1986). Indication species help to identify areas/ecotypes requiring urgent action; complement coverage based on a biogeographical approach; better reflect management actions; are better understood by people as a focal point; have wide public appeal; are more effective at attracting funding; support the biogeographical approach; and have many significant values (genetic, food, ecological, drugs, soil enhancement, cultural).

Box 7–4 summarizes selection criteria that could be used to evaluate and rank candidate areas (MacKinnon et al. 1986; Usher 1986). Millsap et al. (1990) offer a ranking system for setting priorities for species management.

Snow leopards and island biogeography criteria. Many protected area managers and specialists advocate using "island biogeography theory" when debating questions relating to reserve size, shape, configuration, isolation and location (Shafer 1990). Population and other land use pressures have led to increased fragmentation and insularization of pasture areas. Human activities are continually reducing the size of most habitats and ecosystems, so that they are now represented by "islands in a sea of substantially altered habitat" (that is, as individual units, these areas can support only limited numbers of wildlife species or individuals, and are therefore often lacking in terms of biological diversity). As the process of habitat fragmentation continues, nearly all wildlife populations (except for highly mobile species such as birds) are likely to become genetically isolated from one another, possibly leading to induced extinctions.

Shafer (1990) offers a number of general guidelines to design nature reserves under the overall guiding principal that "the more land that can be set aside, the more species that can be preserved". Clearly many other factors – need for agricultural land, industrial production, economics, rural people's willingness to cooperate, to mention a few – determine how much land can realistically be set aside as PAs. The key lies in ensuring that the network of reserves is as well designed as possible, and is based on recognized land planning and biological principles (see MacKinnon et al. 1986:73-98; Noss 1987). Good planning leads to good management and all planning should be based on clearly formulated, sensible objectives.

Box 7–4. Selection criteria for protected areas.

- Size *(must support ecosystem functions and viable populations)*.
- Richness and diversity *(both species and habitats)*.
- Naturalness *(relatively undisturbed areas)*.
- Rarity *(rare and endangered species habitat/populations)*.
- Uniqueness *(supports unusual features of biogeographical zone)*.
- Typicalness *(supports representative habitats of zone)*.
- Fragility *(sensitivity to environmental change)*.
- Genetic conservation *(gene pool conservation potential)*.
- Indispensability *(supports critical habitat/landscape)*.
- Potential value *(restoration potential)*.
- Intrinsic appeal *(educational/recreational values)*.
- Opportunities for conservation *(public support)*.
- Position in ecological/geographical unit (*significance in local habitat/community classification system*).

Based on Shafer (1990) and other documents, the following general recommendations can be made with respect to nature reserve size and configuration:

1. Larger areas usually support more plant and animal species, but beyond a certain point returns typically diminish as the area increases. In general, a large reserve is better than a small one.

2. Habitat fragmentation and nature reserve insularization should be strongly discouraged as having many undesirable consequences.

3. Many large reserves are needed in as many biotic communities as possible, but these reserves must be based on careful field surveys and studies.

4. Small reserves may be useful in facilitating migration of large or wide–ranging species, but in general small populations should be avoided as they are more vulnerable to catastrophes. Also, smaller reserves can withstand less internal or external stress compared to large reserves.

5. If possible, nature reserve boundaries should not have abrupt transitions that discourage animal movement into habitats of the adjacent, unprotected land. In this regard, buffer zones offer a means for minimizing conflict with local people and other land uses.

6. The establishment of corridors between reserves to facilitate animal movement should be based on known ecological needs of the targeted species, as well as a consideration of the pros and cons (costs included) of managing these corridors. Maintaining natural habitat connectivity between PAs is the most prudent course of action.

7. Nature reserves for large mammals should generally be increased in size where the opportunity exists to do so, although buffer zones may offer an alternative to costly or unpopular land acquisition programs. As a general guide, the reserve size should be based on the spatial requirements of the largest widest–ranging mammal species, as determined from life history studies. In this regard, an indicator species can serve as an umbrella for other species.

8. Regional planning for nature reserves must take human population growth into account and consider the social and economic conditions on adjacent lands.

Recent research and modeling suggest that large vertebrate species such as the snow leopard may need populations of several hundred or even several thousand to achieve long–term genetic viability. Rare species such as the snow leopard, which require relatively large home ranges, are most vulnerable to extinction. Because few reserves are large enough to support so many individuals, conservationists need to rely on *Protected Area Networks* connected by intervening corridors and buffer zones. Indeed, studies in Nepal (Jackson and Ahlborn 1990) suggest that most of that country's snow leopard population resides outside its six mountain protected areas. Note that while genetic material could be artificially transferred among isolated populations, the expense and logistics of doing so for snow leopards would be daunting: as rare inhabitants of remote, rugged terrain, they are not easily captured or moved, even if attempts are focused on the transfer of semen only.

Barriers to the dispersal of snow leopards are shown in Box 7–5. A strong argument can be made for linking snow leopard reserves to the maximum extent possible by land corridors and buffers. For example, increasing evidence suggests that the area of potential snow leopard habitat is far from contiguous, given the fragmented nature of many of Central Asia's mountain ranges, and the fact that much of the Tibetan Plateau may represent marginal habitat (frontispiece map). Many parts are either too high to sustain snow leopard prey year–round, lack sufficient forage, or are unsuitable in terms of their terrain – snow leopards seem to require some cover in the form of rocky outcrops, cliffs, or other broken land surfaces.

Box 7–5. Barriers to the dispersal of snow leopards.

- Continuous forests, extensive open plains and rolling hills lacking rocky outcrops or cliffs.
- Lakes or large rivers.
- Corridors that are too narrow to encompass one or a few snow leopard home ranges.
- Extensive snowfields and terrain above 6,000 m in elevation.
- Mountain ranges separated by wide, open low–elevation valleys.
- Scarcity of natural prey requiring snow leopards to subsist on livestock.
- Areas with many people and human settlements.

Therefore, seek to minimize the number of potential barriers within corridors, as these weaken dispersal from adjacent core areas.

The best habitat in a particular region is often located along international borders, arguing in favor of international conservation programs. The establishment of *Transboundary Parks* offers a powerful tool for protecting rare species such as snow leopards. Two good examples of linked PAs include:

- Taxkorgan Nature Reserve (Xinjiang, China), Khunjerab National Park (Pakistan), and Central Kalakoram National Park (Pakistan).
- Sagarmatha (Mt. Everest) National Park and World Heritage Site (Nepal), Makalu–Barun National Park and Conservation Area (Nepal), Langtang National Park (Nepal), and the Qomolangma Nature Preserve (Tibet, China).

Box 7–6 summarizes options for linking separated PAs.

Box 7–6. Linking protected areas with corridors.

- Locate corridors along mountain ranges offering optimal snow leopard landscape, topography, and habitat.
- Implement land–use planning that keeps corridors intact.
- Avoid reliance on narrow corridors encumbered by "bottle-necks" or barriers (corridor should be wide enough to encompass the home range of at least two individuals, or more than 20 to 40 km).
- If possible, select the most direct route to link neighboring PAs.
- Promote development projects that are sustainable, generate income for local people, and which are linked to the protection of wildlife.

Upgrading the national protected areas network. This subject is quite complex and this handbook can only provide a brief introduction. The reader is referred to MacKinnon et al. (1986) and other sources listed in the bibliography.

The IUCN's Commission on National Parks and Protected Areas has developed a classification system for PAs (Box 7–7). This system is currently being reviewed and changes are expected in light of the recent emphasis on park management and integration with local communities. Although national parks and strict nature reserves receive more international attention, they are not necessarily better than PAs in which other uses have been integrated. No park is an island to itself: the presence of seasonal or permanent settlements within most Central Asian parks is a fact of life that cannot be easily altered. Even if no people reside within a PAs boundaries, they may rely on its pastures for grazing their livestock and obtaining medicinal plants or other essential natural resources. Indeed, attempts at relocating people from parks in Nepal and elsewhere have proven disastrous. Papers presented at the 1982 World Congress on National Parks held in Bali, Indonesia clearly indicated the benefit of integrating protected areas with local communities (McNeely and Miller 1985). The protection of rare species and biological diversity depends on people's cooperation and participation, as much as on proper land–use planning and resource management. However, all countries should seek to preserve and maximize coverage of "wilderness areas", including large tracts of land in which there is no extraction of resources by humans.

Box 7–7. IUCN protected areas classification system (*with examples of use and management objectives*).

- Strict nature reserve/scientific reserve *(ensures full protection of natural ecosystems without human disturbance).*
- National park *(protects outstanding natural and scenic areas).*
- Natural monument/natural landmark *(preserves nationally significant natural features of special interest).*
- Managed nature reserve/wildlife sanctuary *(preserves habitat for nationally significant species and biotic communities, allowing some harvesting).*
- Protected landscape and seascape *(maintains significant natural landscapes with recreation and tourism as prime activities).*
- Resource reserve *(protects natural resources for future use and prevents adverse development activities).*
- Anthropological reserve/natural biotic area (*allows traditional uses to continue undisturbed by modern technology).*
- Multiple use management area/managed resource areas *(permits sustained production of water, timber, wildlife, pasture, and tourism).*
- Biosphere reserve *(special UN category of protected area for safeguarding genetic resources of international significance).*
- World heritage site *(area of outstanding universal significance).*

Box 7–8 describes the basic steps involved in establishing a protected areas network. For additional information, see documents cited in the bibliography.

Box 7–8. Establishing a protected areas network.

1. Adopt or develop a protected areas classification system.

   – identify categories and objectives
   – determine gaps in coverage and information needs

2. Develop a list of potential candidate sites.

   – consult experts and conduct field inventories

3. Evaluate and rank each candidate area.

   – how well are selection criteria fulfilled?
   – will local communities be supportive?
   – does it meet criteria of size, shape, habitat and species diversity, and linkage?
   – what are possible administrative constraints?

4. Develop action plan for establishing network.

   – prioritize candidates
   – develop enabling legislation
   – establish protected areas authority
   – determine budget, personnel, and schedule
   – integrate into other regional land–use programs

5. Implementation.

   – establish priority PAs
   – liaison with other agencies
   – ensure community participation
   – develop management plans
   – infrastructure development (roads, facilities, tourism, income generation)

Clearly, any protected areas system should be well–designed and organized if it is to achieve its objectives. Key topics associated with the organization and management of protected areas include (from MacKinnon et al. 1986): national policy and legal framework; policies, purpose, and objectives; responsible agency and administrative structure; operating budget and staff; public participation (NGOs and user committees); management needs and plans; regulations and laws; enforcement; research and education programs; monitoring programs; and dissemination of information and scientific exchanges.

Improve Habitat and Prey Management in Protected Areas

Objectives

1. Develop and implement a Snow Leopard Conservation Plan.

2. Survey protected areas to determine and prioritize management needs.

3. Develop protected area management plans for key reserves.

4. Develop species and habitat profiles.

Outputs

1. National Snow Leopard Conservation Strategy prepared and endorsed at the highest levels of administration.

2. Prey species life history and habitat profiles.

3. Protected area management plans.

4. Conservation activities reported in SLIMS and other national and international newsletters and journals.

Background. Up–to–date information on the status, distribution and threats to the snow leopard and its prey are essential in developing effective conservation programs for it and other endangered species. Implementation of national Snow Leopard Conservation Plans is supported by the baseline information gathered under the SLIMS protocol. Increased populations of rare species can be attained only by extending protected areas coverage and improving management within park and reserve boundaries, and along intervening corridors. The need to integrate conservation with development is urgent. Most importantly, because livestock grazing is the dominant activity in snow leopard habitat, wildlife managers will need to cooperate with range managers to ensure that livestock development projects do not adversely affect biological diversity or habitat quality (Miller and Jackson 1994). The conservation needs of snow leopard and other cats are clearly listed in the IUCN/SSCs Cat Action Plan (Nowell and Jackson 1996); all agencies responsible for managing rare cats should obtain this valuable document.

Conservation is best achieved using an ecosystem approach, with integrated land–use planning at the regional level. Box 7–9 shows possible benefits accruing from PAs managed on an ecosystem basis. Negative impacts can be minimized by establishing buffer zones around sensitive park areas, or by employing the biosphere reserve concept of zonation (Batisse 1986). On a regional scale, resources could be viewed as forming a "triad triangle," with the triangle's base consisting of intensively farmed lands or managed forest lands (*Production Areas*) on one hand and parks or reserves (*Protected Areas*) on the other. The apex would be formed by *Multiple–Use Lands* in which conservation and development are integrated to the maximum degree possible.

Box 7–9. Benefits of management at the ecosystem level.

- Better identifies "desired future conditions" (*the ideal landscape*).
- More efficient at sustaining biodiversity.
- Works with nature rather than against it (*supports natural ecosystems*).
- Considers scale effects.
- Consolidates common land issues by addressing conflicting uses.
- Better ensures people's participation.
- Promotes information exchange and integration.
- Uses models and information from diverse sources.
- Adapts to change (*monitor for signs in changing health*).
- Better integrates monitoring and research endeavors.
- Promotes nature conservation education.
- Works to ensure policy–level changes within government.

However, defining the bounds of an ecosystem is not easy.

Additional Suggested Activities and Actions

Identify Snow Leopard and Prey Management Requirements

While conducting status, distribution and abundance surveys, information should be gathered on such topics as poaching and hunting of snow leopards and their prey, presence or absence of trading in furs and bones (including suspected market destinations), extent of authorized and unauthorized predator control programs, numbers of livestock lost to predators, animal husbandry practices, and the amount and quality of habitat available to cats and prey species. List those factors considered most threatening to the welfare of snow leopard populations, with remedial options and recommendations for action. To what extent is new land settlement occurring in the area? Which areas are used by livestock herders, and is livestock intruding into critical wildlife habitat? Is unregulated road or trail construction permitting access by outsiders involved in illegal hunting for personal profit?

These data also provide the basis for developing a life history and management profile for snow leopard in each country. Topics of interest include status, distribution, abundance, habitats used, other predator species present, principal prey species, conflicts with humans, and other endangered, threatened or protected species present. Summarize the survey findings in one to three pages of text and distribute these *fact sheets* to all agencies and individuals involved in wildlife conservation within the survey area, as well as to the SLIMS node. Additional information on food habits, home range and movements, reproductive biology and other topics could be included to provide staff with more comprehensive fact sheets on life history or habitat.

Develop a strategy and plan for addressing those factors considered to be the most important threats to the well–being of snow leopard, prey species, and their habitat. Box 7–10 lists some options for managing rare species such as the snow leopard.

Management issues of special importance include hunting and conflicts arising from the loss of livestock to wild predators. Hunting is considered the greatest single threat in most parts of the snow leopard's range. Regulations should be reinforced to reverse this threat to wildlife populations. Actions should specifically target persons killing wild sheep, yak, or antelope for profit by selling their meat or wool, persons hunting snow leopards and trading in their bones and pelts, and all others trading in other rare animals such as the Pallas cat, lynx, and wild dog. Besides identifying and policing markets, and educating the public (including foreigners), authorities need to establish check–posts along roads leading from wildlife areas. Such enforcement aids compliance with CITES to which most countries are signatory and improves the country's image abroad.

Box 7–10. Managing rare species.

- Minimize habitat alteration.
- Control illegal hunting and poaching.
- Extend protection to corridors, breeding areas, and critical habitat.
- Implement habitat management and enhancement measures.
- Protect young from predation (including that by humans).
- Control disease.
- Control and eliminate exotic (feral) animals and plants.
- Translocate animals to formerly occupied habitat.
- Restock depleted areas.
- Breed in captivity.
- Review and enhance legislation.
- Implement inventory and monitoring programs.

For example, the decision of the authorities in Qinghai to end the export of wildlife meat to Europe (which resulted in many thousands of blue sheep and Tibetan gazelles being killed between 1981 and 1985) is an example of a positive conservation action. Subsistence hunting, if practiced on a limited scale, is generally sustainable, causing little harm to the breeding stock. Market hunting is another matter entirely.

Programs to enhance cooperation among government agencies, especially those responsible for endangered species protection, livestock development, tourism, and transportation, would benefit wildlife as a whole and lead to wiser resource management land use. Like forests, wildlife represents a finite resource that needs to be managed on a sustainable basis, thus management of resources requires the full cooperation of all parties involved in wildlands (Ledec and Goodland 1988).

Prepare a National Snow Leopard Conservation Plan

Wildlife protection agencies could consider implementing *Snow Leopard Conservation Schemes*, such as that announced by the Government of India at the Fifth International Symposium on Snow Leopards, held in 1986 (Government of India 1988). By implementing a special conservation initiative involving the establishment of protected areas in suitable snow leopard habitat, other montane species are also benefitted. This task requires that surveys be undertaken, followed by carefully defined assessment of goals/objectives and management actions aimed at achieving the desired goal. The resultant plan should be published and disseminated to all governmental agencies, as well as conservation organizations and private or public resource management organizations who might be affected, or whose activities may directly or indirectly affect wildland habitats or wildlife. Such plans should be generated cooperatively with input from NGOs, rural community leaders, park rangers, and snow leopard experts.

Resolve Conflicts with Livestock Herders

Conservation and development would be greatly benefited by *improved livestock management practices* aimed at minimizing people–wildlife conflicts due to livestock depredation or competition for forage resources. In areas such as the Tibetan Plateau, pastoralism and animal husbandry are vital elements in the local economy and in many people's livelihood, but potential problems include overstocking, rangeland degradation, loss of traditional pastoral herding systems, harsh environment and inclement weather, which result in periodic, large–scale die–offs (Schaller et al. 1988; Miller et al. in press). On the other hand, demands for meat, milk, wool, and other products are rapidly increasing in most countries in the region. A cash–based economy is increasingly replacing traditional barter systems. This economy encourages some herders to hunt wildlife and trade for hard cash in pelts, bones, and antlers. Wildlife populations have generally declined in abundance and distribution, especially along road corridors and near settlements (Jackson et al. 1991b; Miller et al. in press). Other rangeland–wildlife issues of concern include competition for forage and habitat, disease, depredation, hunting, and rodent control programs.

Box 7–11 suggests measures for better integrating wildlife conservation and the livestock industry. These measures could include better daytime and nighttime guarding of livestock herds (especially in depredation hotspots), maintaining livestock numbers at or below the area's carrying capacity, and interventions aimed at improving rangeland and forage productivity. For example, productivity (with increased economic return) could be greatly enhanced through the production of winter forage, use of rest or rotational grazing (especially within select pastures), greater emphasis on dairy and other stall fed animals in some regions,

Box 7–11. Methods of integrating wildlife conservation and livestock development.

- Promote multiple–use concepts by regulating grazing and protecting wildlife habitats and species.
- Conduct snow leopard status and distribution surveys (especially in corridors between adjacent protected areas).
- Determine stocking rates and which livestock and wildlife species to promote.
- Conduct food habit studies and rangeland forage assessments.
- Conduct vegetation mapping using satellite images as sources.
- Formulate policies and actions to alleviate depredation of livestock.
- Protect prey species and avoid use of rodent poisoning programs.
- Protect critical wildlife habitat (such as wintering and summer areas) by establishing reserves or special conservation areas.
- Involve local people and try to meet their aspirations in exchange for specified conservation initiatives (e.g., wildlife protection and patrolling).
- Avoid dependence on “improved breeds” of livestock (local breeds are better adapted and are usually hardier).
- Incorporate traditional pastoral strategies and livestock management techniques.
- Create new markets or improve access to existing markets and goods to promote trading and raise incomes of herders.
- Offer veterinary care and services in exchange for wildlife protection.
- Promote other income–generating activities such as nature viewing and cultural opportunities, general tourism, sale of handicrafts, and trophy hunting programs.
- Provide skills and job training for range and wildlife managers.

Adapted from Miller and Jackson (1994)

the refinement of some traditional practices, and less dependence or emphasis on fencing of open rangelands. Livestock development projects could encourage wildlife conservation through application of the multiple land–use concept (Miller and Jackson 1994), and by recognizing all three components of the resource triad mentioned above. Pastoralists could be offered incentives, such as free veterinary services or medicine as a reward for protecting snow leopards and prey species. Such action also benefits the local economy by improving productivity and reducing the incidence of disease.

Small–bodied livestock tend to be more vulnerable than large–bodied animals, although pack–hunting predators such as wolves are capable of killing livestock as large as fully grown yak. Measures to reduce depredation losses, which may be as high as 10% in parts of the Qomolangma Nature Reserve in Tibet or the Annapurna Conservation Area in Nepal (Jackson et al. 1994a,b, unpublished material; Oli 1994b), include improved guarding (especially on the open range or in broken terrain), nighttime corralling in secure enclosures, education of herders, and the use of adults rather than children as guards, allowing a predator to complete its meal rather than depriving it of its kill, and the use of trained guard dogs. The latter measure has proven effective on some rangelands in the western United States where depredation losses are similar to those in snow leopard country. There is circumstantial evidence to indicate that predation loss is greatest in areas where the native prey base (blue sheep, ibex, and marmots) have been depleted, thereby forcing snow leopards and other carnivores to subsist on domestic stock (Figure 7–2). Box 7–12 summarizes some of these options.

Predator bounty programs should be avoided, as they rarely prove effective in controlling predator populations or alleviating livestock losses over the long–term. The use of traps, firearms, and chemical poisons may result in deleterious results, such as killing non–target wildlife, endangering rare species such as snow leopard and lynx, and problematic eruptions of pest species (such as small rodents inhabiting rangeland) caused by upsetting the natural balance. Any control of problem animals should be undertaken only by authorized personnel. For legal and other reasons, predator control should not be directed toward species on internationally–recognized endangered or Red–Data Book lists. Political fallout resulting from bad publicity usually exceeds the benefit associated with removing a few problem animals. In such event, it may be preferable to compensate herders for their loss, but as a general rule use monetary compensation only as a last resort (Jackson et al. 1994b). Contact the International Snow Leopard Trust for more information on addressing this important management issue.

Figure 7–2. Bharal or blue sheep, natural prey of snow leopard (Photo: Rodney Jackson).

Strengthen Protected Areas Management

Actions under this component include development of area-specific management plans, the promotion of tourism development (including non–consumptive uses such as wildlife viewing and nature trekking tours), establishment of special conservation areas or buffer zones, and development of carefully regulated trophy hunting programs aimed at generating revenue without jeopardy to the resource base.

Box 7–12. Reducing livestock depredation.

- Conduct baseline surveys to identify key causative factors and depredation hotspots.
- Avoid or minimize grazing in known hotspots.
- Corral animals at nighttime in predator–proof enclosures.
- Avoid leaving small–bodied and vulnerable livestock unattended in the open range.
- Use trained dogs or more alert herders to guard livestock when free–ranging or stalled.
- Stall feed livestock (a few well–fed dairy cattle may be more productive than many free–roaming animals depending on inferior forage).
- Ensure lambing occurs within confinement in properly protected corrals.
- Permit the predator to complete its meal so that it does not have to kill immediately again.
- Protect key prey species, including rodents.
- Issue "one-time only" depredation permits in case of proven livestock killers (but not for an endangered carnivore species).
- Provide monetary compensation, but only in cases of proven hardship to avoid abuse.
- Compensate affected families by providing other benefits or needed services (e.g., veterinary care, skills training, schools, and other community services).
- Promote alternative forms of income in or near protected areas (e.g., tourism, commercial trading, jobs) to reduce dependence on livestock and diversify the economy)

Governments are increasingly turning to *Buffer Zones* in an effort to strengthen PA management while reducing conflict with nearby residents. Buffers offer a flexible mechanism for resolving conflicts between the interests of conservation and those of the inhabitants of adjacent lands. They extend the amount of habitat, thus benefitting large, wide–ranging animals. Social benefits of buffers include compensating people for loss of access to a strictly protected core zone or conservation area; improving earning potential and quality of the environment of local people; strengthening local and regional support for conservation programs; safeguarding traditional land rights and cultures of local people; and providing animal and plant species for human use and restoring species populations and ecological processes in degraded areas.

The value of buffer zones increases to the extent that the following criteria are met: as far as possible, vegetation and habitat should be maintained in a near–natural state; vegetation of buffer zones should resemble those of the PA in terms of species composition and physiognomy; buffer zones should have similar biological diversity to the protected area; as far as possible, the capacity of the ecosystem in the buffer zone to retain and recycle soil nutrients should be retained. Similarly, buffer zone activities should not have negative impacts on the physical structure of the soil or on its water–regulating capacity; and as much as possible, resource exploitation should make use of traditional, locally adapted lifestyles and resource management practices (see MacKinnon et al. 1986:99–119).

Box 7–13 offers core area and buffer zone measures specifically aimed at maximizing potential for protected areas supporting snow leopard and their prey.

Protected area managers will need to decide which uses have to be regulated. One way of determining these is to classify existing activities in low and high *threat classes*. Examples of low threats include all activities that are consistent with the protected area's objectives or that will not require restriction within the foreseeable future. High threat activities are those that pose immediate threat, are inconsistent with the PAs status and objectives, or that are likely to lead to conflicts over the short term. Negative activities can be regulated in many ways, as indicated in Box 7–14. The reader is also referred to MacKinnon et al. (1986) and other sources in the bibliography provided.

Securing local support for conservation. The concept of *community–based conservation* is a relatively new one (Western and Wright 1994). It proposes the integration of habitat, species, and genetic resource management into rural development schemes – by involving rural people in problem–solving, resource planning and management, and benefit sharing; by making wildlife "pay its way"; and by ensuring that parks benefit more of society than just the urban or international elite. In essence, it espouses bottom–up planning and development in place of the centralized, large–scale, top–down development projects of the past (which have consistently failed, despite massive financial investment, to improve the socio–economic conditions of the rural poor).

Box 7–13. Criteria for protected areas and buffer zones.

Protected or Core Areas

- Large tracts of mountainous land (5,000–10,000 km^2 or larger).
- Areas with no or few permanent human habitations (a density of 1 to 5 villages per 100 km^2 or less).
- Mixture of terrain types, with rocky slopes, cliffs, broken areas, and gorges well represented.
- Habitat for large ungulate prey species (e.g., blue sheep, ibex) over large areas.
- Provide food and cover for all seasons within the PA rather than outside.

Buffer Zone

- Limit expansion of human settlements near PAs.
- Protect prey populations and critical wintering habitat.
- Promote guarding of livestock and construct secure nighttime corrals.
- Minimize hunting or disturbance of wildlife.
- Manage and enhance natural resources, including forage, timber, and fuel to decrease dependency of communities on resources located within the PA.
- Promote tourism development to strengthen PA and generate income for local people.

Box 7–14. Regulating use in protected areas or sensitive sites.

- Provide alternative sources for key natural resources (e.g., fuelwood plantations, construction timber, fodder) and offer incentives for good conservation policies.
- Reduce demands by promoting substitutes or offering cash income to people engaged in damaging activities (without choice) or living near especially fragile sites.
- Regulate sale of products in the market–place.
- Place restrictions on harvesting levels.
- Implement a permit system to control the number of users.
- Restrict access to specific areas, especially for outsiders.
- Restrict the season of use to allow recovery or natural replacement.
- Ensure strict enforcement through imposition of fines and penalties for violators.
- Relocate settlements where politically, socially, and economically feasible.
- If necessary, ban all use of a particular resource until it has recovered sufficiently to sustain use.

Methods for involving local communities have evolved dramatically in the last decade. Among the foremost is PRA or *Participatory Rural Appraisal* (also known as RRA, Rapid Rural Appraisal by some practitioners); for example, see World Resources Institute (1990) and Water–Bayers and Bayer (1994). Interdisciplinary specialists work as a team with local people to acquire information relating to their natural environment and socio–economic welfare, with solutions to the community's real or perceived "needs" being identified within the context of available resources and infrastructure, under the guidelines of environmental and economic sustainability. As a strongly participatory process, PRA emphasizes the need for decision–makers to learn from local people and to use traditional knowledge whenever possible in problem–solving and resource management – if applied properly, it is a bottom–up rather than top–down learning process, involving all key stakeholders. PRA practitioners approach the community with an open mind and not with preconceived notions or solutions, thus serving as facilitators rather than "independent outside decision–makers". Information is freely shared, and the long–term trust and confidence of the community is sought as socially and environmentally responsible management actions are identified and explored in a mutually supportive atmosphere. Different opinions are not seen as threatening, but rather as offering an opportunity for seeking community–based consensus. Interested persons should contact the following organizations for specific information about these techniques: International Institute for Environment and Development, 3 Endsleigh Street, London WC1B 0DD, UK; or Institute of Development Studies, University of Sussex, Brighton BN1 9RE, UK.

Similarly, protected areas management can be greatly enhanced through the development of partnerships between park managers, rural peoples, location institutions, NGOs, and other governmental agencies (Western and Wright 1994; McNeely 1995). The benefits of partnerships include sharing of natural resource management and conservation costs and responsibilities through co–management and benefit sharing agreements; increased local leadership, involvement, empowerment, and environmental awareness; strengthened local capacity for averting environmental catastrophes; greater capacity for supporting traditional land–tenure rights and resource demarcation; increased flow of knowledge and skills in both directions; and potential for ensuring policies and regulations work better at all levels of government and community action. ISLT implements all of its activities through in–country partnerships for these and other reasons.

Thus, it is increasingly clear that local people are far more likely to embrace conservation initiatives if they are offered incentives for good behavior and penalties or disincentives for destructive activities (McNeely 1988). Governments need ways of ensuring that people act of their own free will to avoid resource overuse. Sustainability is best achieved by empowering local people and making them responsible for resource protection according to pre–agreed management prescriptions. Forced restrictions, severe policing and unresponsive bureaucracies rarely lead to enlightened natural resource utilization. Some of the benefits of community management are:

(a) increased support for nature conservation among involved communities;

(b) reduced need for enforcement and patrolling; and

(c) more opportunities for economic and social advancement (improved quality of life and basic needs more likely to be fulfilled).

Recently, a survey of protected areas throughout the developing world, commissioned by the World Bank, noted that projects attempting to link protected area management with local social and economic development faced considerable challenges (Wells and Brandon 1992). These authors concluded that agencies responsible for PAs had limited management effectiveness within the area immediately surrounding the jurisdicted boundary, that many governments were lacking in their commitment to *Integrated Conservation–Development Projects*, and that innovative models for people–parks management are an essential component of sustainable development. Box 7–15 provides examples of incentives that could be offered to people living in or near protected areas, and summarizes incentives and opportunities associated with PAs. Whenever possible, benefits should accrue to local residents rather than outsiders. In reaching conservation or resource management agreements with local communities, managers must establish explicit linkages between development components and conservation objectives.

Box 7–15. Parallel incentives. Sustainable development for local communities and development of protected areas.

- Jobs in previously unavailable employment opportunities *(guides, game guards, drivers, hotel staff, trading, shops, and restaurants).*
- Income from park entrance fees and concessionaire royalties available to help fund development projects that meet community's needs and interests *(roads, schools, health post, shops, and food storehouses).*
- Unique potential for the local community to participate in decision–making and economic development, possibly through user groups and NGOs.
- Increased incentive for improvements to community services *(access, communications, goods, trading, and health).*
- In–kind incentives such as revolving funds, loans, and subsidies for tourism development, livestock products and other locally important, but compatible, economic activities.
- Improved management of local natural resources *(rangeland enhancement, new trading opportunities for pastoralists encourages conservation and sustainable resource use).*
- Enhanced opportunities for training and education.
- Donations of funds and equipment from international organizations to help support mutually beneficial conservation and development programs and activities.

They must ensure that local people clearly understand the nature of the exchange and hold both parties to the conditions of the agreement. Give–a–ways should be avoided at all cost: the most durable agreements are those in which each party contributes valuable resources, whether actual natural resources, cash, time, or labor. Progress should be continually monitored, with penalties or disincentives being applied to discourage infringements. Achievable, measurable goals must be set at the onset; whenever possible, stakeholders should set their own indicators for measuring success (see following section on monitoring).

Preparing Management Plans for Protected Areas

Management plans provide operational guidance to protected area management and development, and are usually written to cover a specified time frame, such as 5 or 10 years (but rarely longer, for management needs and priorities are continually changing).

According to MacKinnon et al. (1986), a management plan also:

(a) establishes specific management objectives,
(b) identifies management steps necessary to meet objectives,
(c) specifies resources needed to implement management,
(d) identifies personnel needed to implement plan activities,
(e) serves as a fund–raising tool, and
(f) aids in training reserve staff.

It should:

(a) be simple and concise,
(b) focus on key protection and management issues,
(c) be flexible and open to change/improvement,
(d) be published in the local language, and
(e) be supported at all levels of the implementing agency.

MacKinnon et al. (1986) identify 16 basic steps in the protected area management planning process, as follows:

Step 1: Form the Planning Team

(a) team rather than individual exercise
(b) multi–disciplinary, covering key disciplines
(c) involve managers and users (all key stakeholders)
(d) ensure local participation
(e) involve personnel from all levels of management

Step 2: Gather Basic Background Information

(a) review all resource information (biological, socio–economic, legislative)
(b) interview knowledgeable persons
(c) prepare base map and reference file system

Step 3: Field Inventory

(a) field reconnaissance to validate information
(b) gather pertinent baseline data
(c) survey critical habitat areas
(d) identify information gaps

Step 4: Assess Limitations and Assets

(a) list all environmental, economic, and administrative constraints
(b) identify scope of limitations and remedial action
(c) involve central administration in discussions

Step 5: Review Regional Interrelationships of the Protected Area

(a) integrate into regional land–use/development
(b) identify need for buffer zones, special arrangements with local residents
(c) ensure compatible land–uses within sphere of impact

Step 6: State Primary Objectives of Protected Area

(a) list values of area
(b) list objectives of area
(c) senior management reviews progress

Step 7: Designate Management Zones

(a) define and establish management zones and define these boundaries
(b) list allowable and prohibited uses for each zone
(c) develop and follow a standard zoning system

Step 8: Review Boundaries of Area

(a) review boundary to ensure maximum ecological integrity (community and boundary survey)
(b) recommend modifications if needed and feasible

Step 9: Design Priority Management Programs

(a) develop specific resource protection and management activities
(b) establish permissible human uses
(c) identify community participation and extension activities
(d) develop research and monitoring program
(e) determine operational, manpower and financial resources
(f) locate headquarters and other facilities with design criteria

Step 10: Prepare Facility Plans and Alternatives

(a) prepare architectural/engineering plans for review
(b) identify alternative designs/reserve classifications
(c) establish access and transportation needs
(d) identify staffing requirements and training needs

Step 11: Prepare Implementation/Operations Budget

(a) preliminary costing for facilities, staff, and annual operations
(b) cost/benefit analysis of proposed plan and alternatives
(c) identify potential financing and cofinancing sources
(d) options for long–term fiscal sustainability

Step 12: Prepare and Distribute Draft Report

(a) prepare draft management plan
(b) solicit review and feedback

Step 13: Analyze and Evaluate Plan

(a) evaluate alternatives and select preferred design option
(b) senior management approves development proposals

Step 14: Design Schedules and Priorities

(a) develop implementation schedule for each activity with realistic time–line
(b) establish implementation priorities
(c) delineate responsibilities and interagency coordination

Step 15: Prepare and Publish Final Plan

(a) prepare and distribute plan to other agencies and key community organizations (see Box 7–16 for contents of a typical management plan)

Step 16: Monitor and Revise Plan

(a) undertake regular project monitoring
(b) review accomplishments after 5 years
(c) make revisions as needed

Monitoring Program Activities and Accomplishments

Short– and long–term goals and objectives are far more likely to be achieved if a plan is in place for assessing specific programmatic inputs, outputs and "status at completion of each distinct activity". By monitoring project effectiveness, researchers and park managers are more likely to justify and receive financial and logistical support for their conservation program. Only by measuring conditions *before* and *after* applied action can one determine if the implemented activities are successfully addressing the targeted problem(s). A number of monitoring techniques have been developed, but most seem to be based on the *logical framework* (Cooley 1989) or the German–developed *ZOPP*, which translates as "objectives oriented project planning". While this technique is difficult to initially grasp, it is more apparent if one uses its underlying principles to develop programs from the onset.

The logical framework recognizes the importance of addressing unanticipated factors which may weaken a project by clearly specifying each assumption necessary to assess the underlying program's validity. An assumption is something that is taken for granted, but which may be false, thus resulting in a different outcome than originally anticipated. Questioning the underlying assumptions is done at three levels: *inputs* (the various resources consumed, including human skills, and the individual activities undertaken in anticipation of achieving a particular objective); *outputs* (the anticipated results that a program manager is committed to or expected to produce); and *purpose* (the higher–level objective that caused us to invest in producing outputs, but over which we have more limited control). Too often, confusion or misinterpretations arise from poorly expressed statements of goals, purpose (objectives), output and input. All existing and potentially affected stakeholders need to be identified and brought into the planning process.

The logical framework asks that the major assumptions affecting each level of action be identified and articulated, so that program managers better understand factors within or outside their immediate control. Once these assumptions are identified, one may better assess the feasibility of the project, and adjust or redesign specific activities where possible to reduce uncertainty about the outcomes. Once a project begins, a good manager monitors its progress

Box 7–16. Headings and content of a typical management plan.

Chapter 1. Background
- Rationale for establishing protected areas
- Regional and biological context and setting

Chapter 2. Description and Inventory
- Landform, geology, soils
- Climate
- Biological and ecological features
- Socio–economic context
- Cultural features
- Other significant features

Chapter 3. Management Considerations and Objectives
- Park zoning, use, and classification status
- Important constraints and opportunities
- Reserve objectives

Chapter 4. Management Programs
- Conservation activities
- Species and habitat protections program
- Community education and participation program

Chapter 5. Development Program
- Facility development plans and implementation schedule
- Financial and personnel requirements

Chapter 6. Research and Monitoring Program
- Research priorities and planned activities
- Monitoring program, criteria, and schedule

Appendix: Supporting information (e.g., species checklists, boundary descriptions, references, socio–economic, vegetation, and climatic data, maps and aerial photographs)

Adapted from MacKinnon et al. (1986)

regularly, so that corrective actions may be taken in a timely manner. Assumptions are also important during a post–project evaluation because their examination can offer insight as to why the project succeeded or not in achieving its stated objectives.

Clarifying assumptions allows for better communication between project staff and sponsors, since managers cannot be held responsible for something beyond their control. Knowing some of the activities depend on factors beyond their control, managers may avoid taking action out of fear of failing and thus incurring the wrath of their superiors. This can easily happen if internal and external constraints are not identified in program planning documents. If an assumption later proves to be invalid, at least the manager is in a better position to communicate openly with superiors with respect to accountability.

Next, the desired end of project status needs to be clearly articulated. Only then can targets and indicators be identified. Targets are the conditions that signal successful achievement of the project objectives. Indicators demonstrate results but are not themselves the conditions necessary to achieve such results: rather, they show and measure whether a specific change has occurred or not. It is imperative that project objectives be measured by such specific indicators as quantity (how many), quality (what kind), and time (by when). Indicators may measure project performance directly or indirectly. The same indicators that demonstrate success at a low level (i.e., the input or output level) cannot be used to measure success at a higher level (i.e., purpose or goal). Success at higher levels is often not measured in tangible ways, but rather in terms of changes in the attitudes of people, or in the practices of local people, which may be hard to see or measure. Here one needs to interview beneficiaries before and after the project to determine if perceptional shifts are being achieved.

Project stakeholders, beneficiaries, and key community representatives need to be involved at all stages of monitoring and evaluation, so that they develop a strong sense of ownership for the program and work harder to achieve intended results. Local residents should be queried to determine their criteria or measures for a successful project outcome. If possible, these indicators should be measured through participatory monitoring, in which all key stakeholders are given responsibility for tracking the program's effectiveness. Of course, there are limitations to implementing monitoring and evaluation plans. For example, resources or staff may be unavailable, or the project might simply be too small or short–lived to warrant intensive monitoring.

Box 7–17 shows the format for developing a summary chart, while Box 7–18 offers a specific example, in this case SLIMS Training Workshops. Box 7–19 provides additional guidelines and examples for selecting indicators and specifying their quantity, quality, and time frame.

Annual Operational Plans

Management agencies may also wish to prepare *Annual Operational Plans*, which build on management plans by: identifying current annual operational activities; focusing on major management problems; describing programs for resources, visitor use, research, and administration; prioritizing reserve management programs; addressing limitations in staffing and budget; listing specific staff responsibilities; providing detailed budget with time–lines; and highlighting interagency coordination.

Administrators need to appreciate the importance of supporting and promoting applied research programs (Harmon 1994). Well–designed research projects serve to provide accurate and scientifically valid data of direct value to the management of protected areas. To this end, wildlife agencies need to encourage research projects that: inventory plants, animals and habitats; describe important ecological relationships; identify cover, food and reproductive needs for representative species; monitor change in habitat and plant and animal communities; and predict the effect of specific management practices and habitat manipulations.

Finally, reserve administrators need to use human and financial resources efficiently while attempting to meet their goals and objectives: motivated staff is the greatest asset that a protected area can have. Staff and their families need good working conditions and each person's role needs to be matched with his or her skills, work aptitude, and responsibilities, to maintain team spirit, discipline, and morale. This goal requires that staff be as well equipped as possible for the job at hand, that detailed work duties outlining responsibilities and expectations be developed for each posting, and that all staff submit regular progress reports to their superiors. Incentives need to be offered for good work and local people should be hired and trained if necessary. They are more likely to relate well to the local community and have a vested interest in the area than a person from the outside.

Box 7–17. Logical framework for summarizing project design – *Program/Project Name.*			
Narrative summary	Indicators and targets	Means of verification Sources of data	Important assumptions
Mission (program) **Goal (project)** Highest level objectives proposed and stakeholders served.	Measures of goal achievement Indicators at this level are imprecise.	How indicators will be measured Trends suggesting society might be attaining long–term goals.	Factors affecting the long–term value of proposed program/project.
Purpose Objective or set of objectives which motivate investment in the program.	Objectively measurable indicators The end of project status: Conditions that will indicate the purpose has been achieved (before and after project conditions). Several indicators may be required, which directly measure key objectives, and are not the same as those used for lower levels.	Measures and results confirming project purpose is being achieved, as indicated by project–related reports and documents (prepared by program staff based on plausible indicators, study monitoring, and end of project evaluation, preferably by independent evaluators).	Factors affecting linkages between purpose and goal.
Outputs (Results) Results that manager is committed to produce, given inputs listed below.	Magnitude of outputs necessary and sufficient to achieve purpose.	Direct measure(s) confirming project output has been achieved: Determined by objective evaluation organized by program managers (i.e., internal documentation).	Factors affecting linkages between output and purpose.
Inputs (Activities) The resources consumed and activities undertaken.	Indicators at this level must be very specific and targeted. (Level of effort/expenditure for each activity undertaken).	Internal documentation showing number of person–hours/months and dollars expended in project activities.	Factors affecting linkages between inputs and outputs.

Box 7–18. SLIMS field training workshop – project design and monitoring. Logical framework for summarizing project design. *SLIMS* field training workshops.

Narrative summary	Indicators and targets	Means of verification Data sources	Important assumptions
Goal Improve conservation of snow leopard and its mountain habitat, especially in protected areas.	Wide–reaching evidence that snow leopard populations are increasing, while people/wildlife conflicts are being satisfactorily resolved.	Observations of government agencies and regional conservation NGOs.	Government and local people wish to preserve snow leopards and their habitat, and resolve resource management conflict.
Purpose Workshop trainees will conduct regular status and distribution surveys of snow leopards and prey species across their range in two countries (Pakistan and Mongolia); implement measures to enhance protected area's management.	Each country conducts at least one status survey annually, especially in or near its key protected areas, starting in February 1995.	Increased knowledge of snow leopard status and distribution. Improved reserve management, as indicated from independent sources, reports at triennial symposia and scientific literature.	Reserve manager uses information and recommendations provided by field survey staff to improve reserve protection and management.
Outputs Biologists and reserve managers trained in standardized field survey techniques and reserve management strategies.	Workshop participant(s) convey their knowledge and skills to other reserve staff and seek supervisor approval for undertaking regular status/monitoring surveys by January 1994.	Field survey report(s) filed with ISLT; country requests support to implement SLIMS database.	Trainees are willing to follow through by undertaking surveys and are afforded the resources to do so.
Inputs Produce Conservation Handbook defining survey methods/procedures. Hold a training workshop in Pakistan and Mongolia for in–country wildlife or protected area management agency professionals.	Two instructors available to commit at least 21 days of their time (8–day workshop followed by 13–day joint survey). Conservation Handbook and data forms available in local language.	Trip report identifying specific input activities and level of effort expended.	Target countries willing to assume responsibility for identifying prospective trainees and assist in workshop logistics.

Box 7–19. Management responsibility and indicators of success.

Managers are only responsible when outputs have been carefully defined, all assumptions beyond their immediate control identified, and after they have been empowered with appropriate responsibility and resources. Specifying these factors allows all concerned to focus on *what* the project is intended to accomplish, *how* it can be accomplished, which elements are *outside* the control of the project and its administrators, *who* is responsible for what, and *when* different levels of management should be involved.

Example for End of Project Status (EOPS):

Purpose	EOPS
Example 1:	
Workshops in snow leopard countries to promote surveys using standard field methods	<u>Targets:</u> Workshops which train at least 5–10 professionals in each of four countries (Pakistan, India, Mongolia, and China) in SLIMS standardized field methods and reserve management. <u>Indicators:</u> Trainees conduct snow leopard and prey species status surveys in at least one new area every year, as well as regularly monitoring populations in key protected areas; improved knowledge of the status (abundance/distribution) of snow leopards and large ungulate species; regular snow leopard and status reports prepared and disseminated.

Indicators demonstrate results. Be specific: they must measure what is important; indicators must be plausible; indicators must be targeted; and indicators must be independent (same indicators that demonstrate achievement of an objective at a lower level cannot be used to demonstrate achievement at higher levels). Good indicators may not always be available and we might have to use surrogate measures. For example, estimation of blue sheep densities is difficult and time–consuming. In the example below, what indicators can you suggest for monitoring blue sheep status and rangeland condition?

Box 7–19. Continued.

Example 2:

Purpose: Income from livestock products increased and number of depredation losses by snow leopard reduced in Area X.

Indicators: #1 – 500 herders in Area X owning locally adapted breeds of goat increase their annual household revenue by 50% between October 1990 and 1995.

#2 – The number of goats and sheep reported killed by snow leopard and other predators in Area X declines by 80% by October 1994.

Other Desirable Objectives:

– Sheep and goat herds are maintained within the carrying capacity of rangeland in Area X by October 1995.

– The number of blue sheep in Area X increases to an average density of 5 animals/km^2 by October 1995.

Step 1: Identify Indicator

#1 – Increased household income from wool sales.

#2 – Fewer goats and sheep killed by snow leopard or other predators.

Step 2: Set Quantity

#1 – 500 herders in Area X owning locally adapted breeds of sheep and goats increase their annual household revenue by 50%.

#2 – The number of goats and sheep reported killed by snow leopard and other predators in Area X declines by 80%.

Box 7–19. Concluded.

Step 3: Set Quality

#1 – 500 herders in Area X (owning locally adapted breeds of sheep and goats) increase their annual household revenue by 50% without loss in wool quality or rangeland condition

#2 – The number of goats and sheep reported killed by snow leopard and other predators in Area X declines by 80% without a decrease in the number of snow leopard or blue sheep.

Step 4: Specify Time Frame

#1 – 500 herders in Area X (owning locally adapted breeds of sheep and goats) increase their annual household revenue by 50% without loss in wool quality or rangeland condition between October 1990 and 1995.

#2 – The number of goats and sheep reported killed by snow leopard and other predators in Area X declines by 80% by October 1994 without a decrease in the numbers of snow leopard or blue sheep in the area.

Chapter Eight - Literature Cited and Selected References

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Appendix A. Distinguishing Snow Leopard Sign from that of Other Species

Obviously, it is important to clearly distinguish snow leopard sign from that made by other species (Figure A–1). Only under ideal conditions is it possible to reliably identify snow leopard sign based on the presence of one type of sign only (e.g., track, scrape, scat). Although no canid leaves a scrape like that of the snow leopard or common leopard (*Panthera pardus*), decisions are better based on multiple pieces of evidence (all of which should be documented in field notes, and photographed whenever possible). Even then it is very difficult to separate common leopard sign from that of snow leopard, or to distinguish tracks of lynx (*Lynx lynx*), which are similar in size to those of subadult snow leopards. This is a definite problem in areas where these cat species are sympatric or overlap (e.g., parts of Ladakh and much of the Tibetan Plateau). In these cases, other types of sign must be considered, including characteristics of sign placement, to reach an informed decision – or informed guess – realizing that mistakes are often made.

Thus, accurate and consistent identification of tracks or scats, in isolation, is probably not possible, especially among felids. There are many similarities among the sign of different carnivores and to compound the situation, a great amount of variability exists in terms of size or shape, even within the same species. Tracks vary in appearance depending on the individual's size, its gait, slope steepness and the type of substrate. Tracks made in snow are especially subject to variation, as melting rapidly distorts and enlarges prints. It may not even be possible to separate felid tracks from those made by canids. For example, Schaller noted it was sometimes difficult to distinguish between common leopard and dhole (*Cuon alpinus*) tracks in Sechuan. Similarly, bears may claw–rake tree trunks (although their tracks are very distinctive and human–like). Therefore, it is essential that the observer consider the entire evidence available, including the full repertoire of the marked pattern and its associated sign, upon which to base species identification. However, the relatively unique characteristics of scrapes possibly provide the best evidence for discerning snow leopard sign from that of other species. Differences in bile acids have been used to distinguish between felid scats or between felid and canid scats, and species are being separated on the basis of DNA extracted from feces, but the methodologies are neither practical nor cost–effective.

Cats: Table A–1 summarizes some of the marking patterns shown by Asian felids (adapted from Wemmer and Scow 1977). Obviously factors such as habitat, elevation, and track size serve to separate the clouded leopard (*Neofelis nebulosa*) and the tiger (*Panthera tigris*) in places where these species are said to occur in proximity such as the Namdapha National Park in India.

Common leopard: Although common leopards are considerably larger and heavier than snow leopards, their tracks are similar in size. Depending on the medium, common leopard tracks vary in width from about 6 to 9 cm, while their scats are 1.9 to 3 cm in diameter. Fully grown male snow leopard tracks are 9 to 11 cm in width and their scats are similar in size to

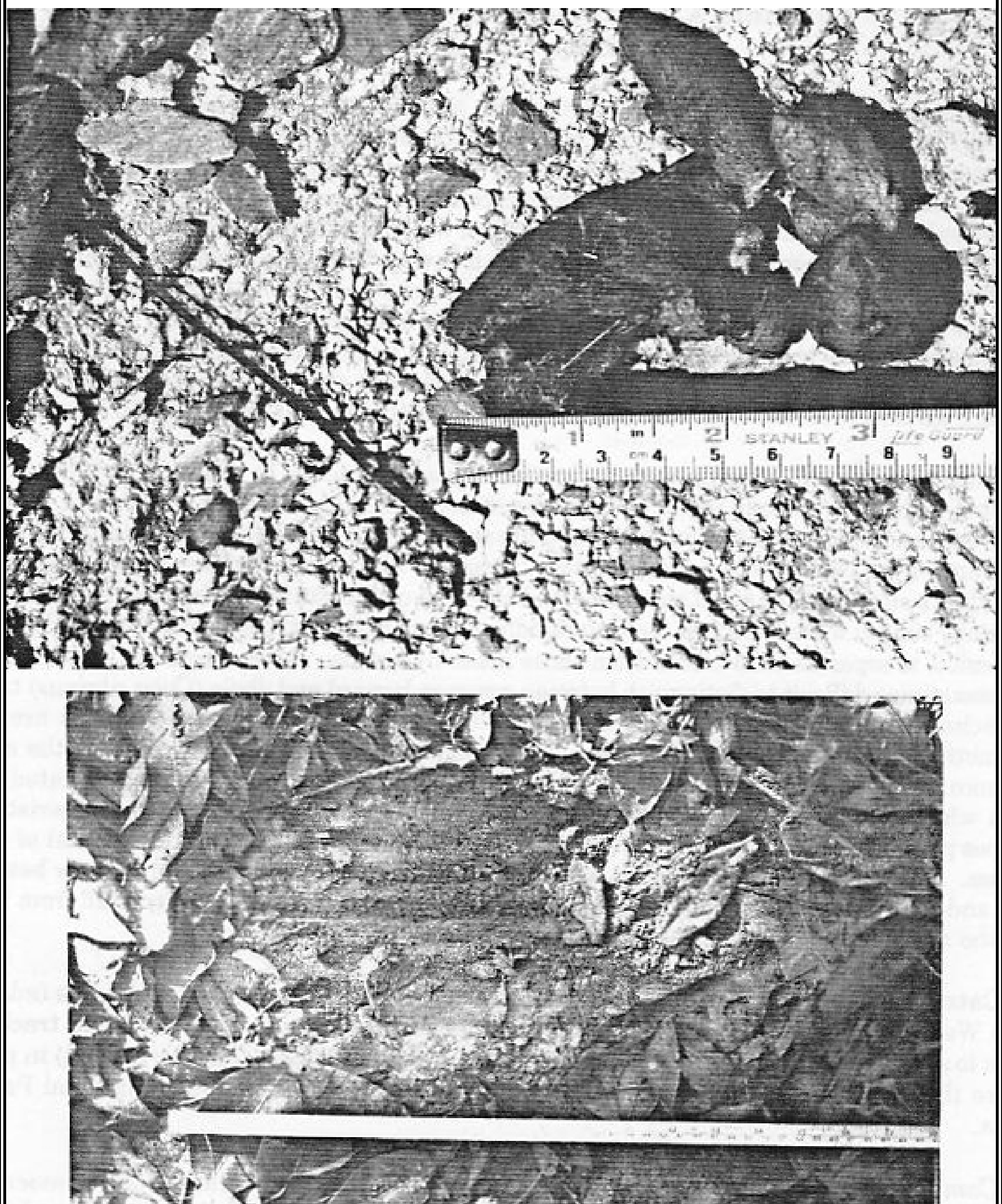

Figure A–1. Feces or scat of snow leopard (Photo: Rodney Jackson) and scrape of the forest leopard (Photo: Charles McDougal).

Table A–1. Marking patterns of selected Asian felids.

Type of marking[a]	Snow leopard	Common leopard	Lynx	Clouded leopard
Scrape	yes	yes	yes	yes
Rescrape	yes	yes	yes	yes
Scrape with feces	yes	yes	yes	yes
Cover feces	no	no	yes	yes
Urinate on scrape	yes	yes	yes	no
Scent–spray	yes	yes	yes	no
Cheek–rub	yes	yes	yes	yes
Claw–rake	yes	yes	no	no?

[a]Based on observations from captivity, the wild and closely related subspecies (e.g., Canadian lynx).

those of common leopard. Notable differences between common and snow leopard scrapes and tracks are listed in Tables A–2 and A–3, respectively.

Scrapes of the two cats are similarly directed toward vegetation (tufts of grass or small woody plants), located along edges and well–defined travel lanes (trail, forest/grassland edge), and often marked with urine or feces. Both have an impression of the hindpaw when the tracking medium is good. Reports suggest that in some places common leopards urinate or defecate on scrapes more often than appears to be the case for *Uncia uncia*. In Thailand, common leopard scrapes are most often observed during the rainy season and scrape density was found to be highest in areas of range overlap.

Table A–2. Relative differences between common and snow leopard scrapes.

Characteristic	Common leopard	Snow leopard
Orientation of scrapes to the trail	Parallel to trail Beside the trail	Any orientation to trail On or beside the trail
Orientation of scrapes in a scrape group or cluster	Cluster linear as a long "string" of scrapes	Cluster circular as a "tight group" of scrapes
Scraping behavior	Rescraping of the same scrape or cluster of scrapes is uncommon	Rescraping of the same scrape or cluster of scrapes is very common
	Therefore, traditionally used scrape clusters or "relic scrape sites" are not established. Scrape clusters appear ephemeral rather than sculptured	Therefore, traditionally used scrape clusters or "relic scrape sites" are established. Scrape clusters acquire a sculptured appearance
Visual attributes of scrapes	Small pile of soil behind the scrape depression	Large pile of soil behind the scrape depression
	Toe and/or claw indentations are frequently found in scrape depression	Toe and/or claw indentations are not frequently found in scrape depression
	Pugmark frequently found at front of the scrape depression	Pugmark not frequently found at front of the scrape depression
	Scrapes appear to be hastily made Scrapes appear to be longer, narrower, and more linear in shape Scrape depression shallow	Scrapes appear to have been made with care Scrapes appear to be broader, shorter, and more heart–shaped Scrape depression deeper

Table A–3. Relative differences between common and snow leopard tracks.

Common leopard	Snow leopard
Less pronounced anterior and posterior heelpad lobes	Anterior and posterior heelpad lobes very well–defined
Less pronounced creases in the heelpad	Heelpad creases well–developed
A more rounded heelpad shape	Heelpad shape more angular

By contrast to scrapes made by common leopard, those of snow leopard tend to be better defined, broader, shorter, and more heart–shaped. Snow leopard scrapes have a larger pile of substrate material at one end, a deeper depression, and a more sculptured appearance. Apparently, the paw motion of snow leopards during scrape formation differs from that of common leopard in that its paws are moved parallel to one another. Scrapes of the common leopard are made as each hindpaw is moved over the same area that the other scraped, suggesting greater overlap between left and right paws in creation of the scrape. Perpetual reuse (i.e., re–scraping of specific scrapes and scrape clusters) of sites by snow leopards leads to the formation of "relic" sites with scrapes of various ages. This marking behavior is not documented for common leopards.

There are undoubtedly differences in scrape site selection between the two leopard species. While both mark along travel lanes and well–defined edges, snow leopard scrapes are usually made at the base of boulders, along the base of cliffs and atop promontories. Common leopard scrapes in Nepal seem to be associated more with vegetation, such as a prominent tree or shrub. However, in less densely vegetated areas this pattern may not be followed. Common leopards also tend to scent–mark tree trunks or shrubs rather than rock faces.

Both species commonly scrape along livestock or human trails, which in some areas appear to comprise the main travel routes. In areas of sympatry with forest leopard it is not possible to distinguish between scats of the two species.

Lynx (Lynx lynx, formerly known as Felis lynx): Adult lynx pugmarks are similar in shape, and about the same size as those made by a subadult snow leopard (Mallon 1987). However, hair marks are usually present between the toes, while the heelpad is small in relation to the toes (Rezendes 1992). While little is known about marking behavior in the Asiatic subspecies, they appear to deposit feces at common, well defined "latrine sites or middens". In Ladakh, some individuals covered their feces (Chundawat, personal communication). Kills may or may not be covered. Another diagnostic feature of lynx tracks might be the differing size of the two central pads, the inner one being slightly larger. Halfpenny (1986) indicates that the North American subspecies may often urine spray along trails, on stumps or bushes, make no attempt to cover feces, and make only poor attempts to cover the remains of their kills. However, captive lynx of the Canadian subspecies are known to make untidy scrapes, use communal latrines (where they scent–spray, urinate and defecate), and to cover their feces. In captivity they also spray upright objects and urinate on scrapes. Whether these patterns occur in wild lynx is not certain. The Spanish lynx (*Felis lynx pardina*) was reported to deposit scats near intersections in trails (Robinson and Delibes 1988), but these investigators made no mention of scraping. Mallon (1987:22) noted that Asian lynx do not scrape. If this holds, scraping or the lack of it could serve as a very important clue for separating these two felids. The possible covering of feces in lynx may constitute another criterion for separation.

Important differences between lynx and snow leopard tracks include:

1. The straddle width of a lynx trail will be less then 18 cm and of snow leopards about 25 cm.

2. The stride length of the lynx is about 36 cm and about 70 to 90 cm on level ground for snow leopards (Fox 1989). Subadult snow leopards cannot be reliably distinguished by their stride from lynx.

3. The fore–pugmarks of an adult lynx may be 8 to 9 cm in length and slightly less in width (Rezendes 1992).

4. The pads of lynx may have more fur, and thus their tracks might be less distinctly outlined. However, Himalayan races have little fur between their pads by comparison to the Canadian race (see Mallon 1987).

5. In deep snow there will be no tail impression associated with lynx tracks, as its tail is very short. By contrast, the long tail of the snow leopard often drags behind in deep snow.

6. A distinctive feature of the European lynx is the differing size of the two central pads; the inner one is said to be slightly larger.

Canids: Many species of canids occur in regions potentially occupied by snow leopards. The most common species and those most likely to leave sign that might be confused with that of snow leopard include the wolf (*Canis lupus*), dhole or Indian wild–dog (*Cuon alpinus*), Asiatic jackal (*Canis aureus*), red fox (*Vulpes vulpes*), Tibetan sand fox (*Vulpes ferrilata*) and domestic dog. Pronounced differences between the pugmarks left by canids and felids are listed in Table A–4, while Figure A–2 indicates differences in stride. Canid pugmarks usually show toe marks, although this is not always the case. Figure A–3 shows wolf and red fox pugmarks. Canid pugmarks lack the double lobe on the heelpad so characteristic of most felid tracks. In deeper soil, a pyramid forms between the toes and the heelpad (as opposed to a ridge in felids). Canid pugmarks also tend to have a proportionately smaller heelpad than is the case for cats. Canid scrapes tend to be long and narrow, usually with claw marks evident.

Canid scats tend to be long with tapered ends, compared to felid scats that are short and segmented. However, note that drier food sources and habitats tend to result in feces that are more segmented than is the case for moist food items (Rezendes 1992). Canids often deposit scats in groups of varying ages along the trail (especially at trail junctions, bends, and other prominent places) or beside *mani* walls or other structures. In North America, there is considerable overlap between wolf and coyote scats in terms of size, and the same must be true of wolf and the Asiatic wild dog. It is doubtful that snow leopard feces can be reliably distinguished from those left by wolves as these two predators may share the same prey items and wolf scats are often short and segmented as well. However, wolves and wild dogs tend to make scratches rather than scrapes. These scratches lack piles of substrate, are usually poorly defined, and exhibit distinct claw impressions (as canids make fewer repeated movements with hindpaws compared to *Panthera* spp.). Canids will often urinate beside scratches or scats. Wolves often direct their scent–marking at prominent upright objects, like *mani* walls. Wolves tend to be more cautious, approaching such objects indirectly. Thus, if there is snow on the ground, and the tracks lead directly to a scent post, suspect a domestic dog (especially if their pugmarks are large). The large pugmarks of a wolf serves to distinguish them from most dogs, except for the Tibetan mastiff. For information on marking in canids and wolves, see Ginsberg and MacDonald (1990) and Peters and Mech (1975).

Birds: Many species of gallinaceous birds (e.g., *Tetraogallus* spp., *Perdix* spp., *Lerwa* spp., etc.) leave sign that could be confused with snow leopard sign. The roost or dust bath sites of these birds are often located under rock overhangs where one would expect to find cat scrapes. Such roost sites usually exhibit a well formed oval or rounded "bowl shape" with substrate material piled evenly around the depression perimeter. One to several depressions may be found at a particular location, but the presence of bird droppings, feathers or bird tracks is usually evident. Several of these birds forage by digging or rooting in the soil. The resulting sign differs from cat sign in that the substrate is scattered in all directions and the shape of the depression is typically very jagged.

Table A–4. Differences between canid and felid pugmarks.

Canid pugmarks	Felid pugmarks
Claw impressions generally present due to non–retractile claws, although toe marks often present in mud or deep substrate	Claw impressions rarely present because of retractile claws
Front pugmarks are larger than rear pugmarks, but less pronounced than in felids	Front pugmarks are distinctly larger than rear pugmarks
Overall shape is generally rectangular, since the pugmark is noticeably longer than wide	Overall shape of the forepaw is round or as wide as it is long
The heelpad tends to be triangular and pointed as there is only one anterior heel lobe and three posterior heel lobes	Presence of two anterior lobes and three posterior lobes in heelpad
Typical gaits are “C–shaped”, rotatory gallop and 2 X trot, with both hindpaws on the same side of the line of travel	Common gait is a deliberate walk, so that pugmarks are usually well–defined. For bursts of speed over short distances, the gait may be a “C–shaped” rotatory gallop. In snow, fore and hind pugmarks may overlay one another

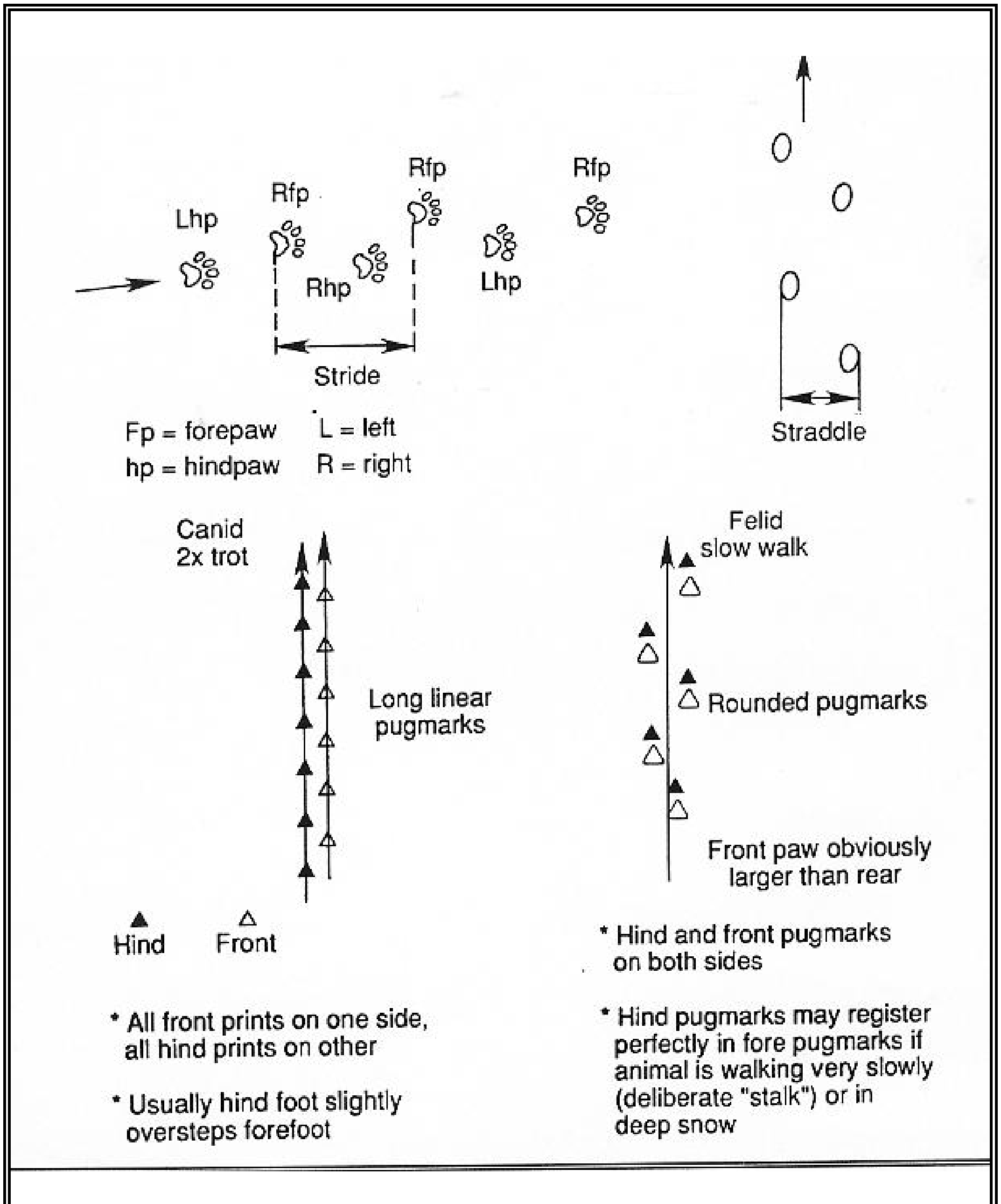

Figure A–2. How to measure stride and distinguish between felids and canids.

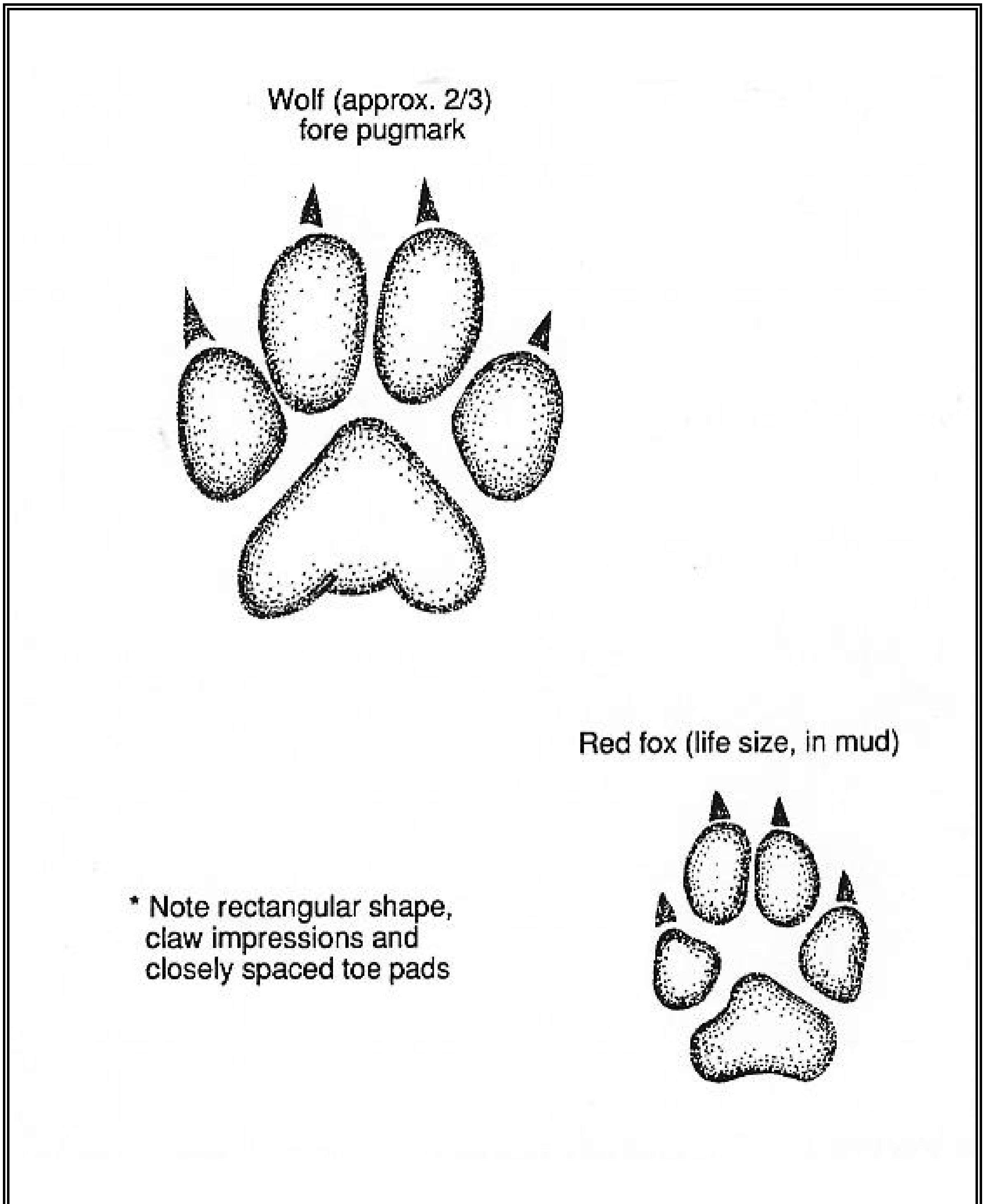

Figure A–3. Wolf and red fox tracks.

Appendix B. Ungulate Distinguishing Features and Age Classes

Blue sheep (*Pseudois nayaur*)

Known as rock sheep in China, bharal in India and naur in Nepal. Closely associated with cliffs and rocky terrain. Generally found above timberline, from about 3,500 m to 5,500 m. Rolling grassy or brushy slopes near cliffs (escape cover). An important item in the diet of snow leopards.

Blue sheep are essentially Tibetan in distribution, living in herds of up to 80 or more individuals. Groups of 5 to 20 are more typical, usually composed of both sexes. All male herds are more readily seen during summer. Blue sheep rut in December and January, with the young being born late May or early June, usually in very broken, rocky areas.

Sheeplike in appearance, blue sheep actually exhibit the behavior of a goat. Males stand about 3 feet high at the shoulder and are best identified by their brownish gray tinged with slaty blue body color, black flank stripes, white insides of legs and dark chests. Tail naked on underside, no callouses on knees. The cylindrical horns curve outward; in older animals, tips are directed backward. Females lack stripes and have thin horns.

Lamb–of–year (less than 1 year of age): Small, grayish, usually with wooly tuft of hair on crown. Male distinguished from female after February (at age 8 months) by its larger size and short horns (less than 5 cm in length), visible at short range.

Yearling (1 to 2 years): Males are about two–thirds as large as an adult female, but lack the dark flank stripe (although the leg may have dark marking); horns shorter (less than 15 cm or 6 in) than those of a female. Female yearlings are smaller, with shorter and thinner horns that are usually only just visible. Some yearlings may have a wooly crown. The sexes are most easily distinguished from close range after fall.

Adult female: Stands about 87 cm (34 in) at the shoulder, weighs about 39 kg, and has horns that are less than 20 cm (8 in) in length. The horns are thin and spindly, often malformed with a “knobby” appearance. Lacks the black chest and dark flank stripe of an adult male, although some individuals may slightly show these features. A wooly crown may be present in some females.

Adult male: Unmistakable, standing some 91 cm (36 in) high, and weighing about 60 kg with spreading horns up to 78 cm (30.5 in) long. In winter, its pelage is slate blue with white legs and belly. Males have distinct black flank stripes, a dark blue–black chest, black foreleg stripes, and a dark dorsal stripe. Their horns are broad at the base but lack the corrugations found in wild goats. They curve upward, outward, and backward with a slightly upturned tip. Horn shape is the main feature for distinguishing age classes in males.

Class 1 male (about 2.5 years): Same size as an adult female, but lacks a flank stripe and has longer, larger horns (25 cm or 9.5 in) that point up but hardly outward.

Class 2 male (3.5 years): Same size or larger than an adult female. A faint flank stripe is usually present. The horns (35 cm or 13.5 in) flare upwards and out, but barely backwards.

Class 3 male (4.5 years): A definite flank stripe is present. The horns are noticeably bulkier, but do not extend far backward. Has a dark chest.

Class 4 male (5.5 to 7.5 years): Bulky with black chest, neck, and foreleg stripe. Stout horns that sweep out and far back (45 cm or 17.5 in).

Class 5 male (more than 7.5 years): Fully grown with massive horns (longer than 50 cm or 19.5 in).

Class 4 and 5 are often difficult to tell apart because horn tips often become broken or because of tip–brooming, and are therefore usually grouped together.

Horn growth may vary widely due to differences in diet and nutritional values from year to year. The only reliable means of aging is to count the horn rings, but one has to be very close to see these clearly.

Other identifying features: Lambs closely follow ewes; ewes are more wary and alert, often leading the group; yearlings, especially the males, indulge in mock clashes and butts; yearling males have a dark belly spot that is the penis (a sure way of separating them from adult females); the scrotum is usually visible in males older than Class 1 and very evident in Class 4 and 5 males (during the rut, these classes have very swollen necks and prominent penis "bulges"); males older than 4 years will spend much time in aggressive display during the rut, following females closely, checking their genital region and their urine to assess when they come into heat. Males are usually present in all groups, since separation of the sexes is not as strong as it is in other wild sheep or goats. However, if groups of all males are seen, they usually consist of those males which are older than 3.5 years.

When young, lambs are obvious (small, grayish, stay close to ewe), but it may be difficult to sex them.

Table B–1 describes distinguishing features of blue sheep sex and age classes.

Table B–1. Blue sheep sex and age classes.

Feature	Adult female	Male yearling	Female yearling	Male lamb	Female lamb
Size (in winter)	Large	Nearly as large as a female	Intermediate	Intermediate	Noticeably smaller
Horns	Thin, crooked spindly, curved back, one often missing	Thicker, flare out slightly	Thin, straight < 10 cm	Thin, straight slightly flared	Barely visible
Tuft of hairs on crown	Usually absent	Absent	Present	Present	Present
Urination posture	Squat low	Stand	Squat low	Stand	Squat low
Behavior	Chase yearlings from lambs. Lead group in escape	Sniff anal area (urine). Aggressive indulge in mock clashes	Docile	Butt and chase other lambs	More docile
Other	Usually no flank stripe	Flank stripe faint; dark spot on belly (penis)	No flank stripe	No flank stripe; penis visible	No flank stripe

Argali (*Ovis ammon* ssp.)

Based on Schaller, 1977, page 104 (Mountain Monarchs, University of Chicago Press)

Argali are the high altitude sheep of Central Asia's rolling treeless, arid hills. They occur in small herds and are thought to be very vulnerable to human disturbance. Rams are larger than blue sheep and easily distinguished by their noticeably white rump patches and whitish legs/bellies. Tail short. Pelage is light brown. Adult males have heavy horns of large circumference, as well as a distinctive neck ruff. Straw–colored horns form an open, outwardly extended spiral in which the tips arc up, out, and down again.

Lamb–of–year (less than 1 year of age): Only found in female or nursery herds. Small, wooly, remaining close to mothers.

Yearling (1 to 2 years): Yearling rams are slightly smaller than ewes, but their horns are bigger.

Adult female: Ewes lack ruffs and dorsal crests, and have less prominent rump patches. Stand between 104 to 112 cm at the shoulder, weigh around 65 to 70 kg and have short horns, about 37 cm in length or less.

Adult male: Unmistakable sheep, standing some 100 to 120 cm high, and weighing between 90 and 126 kg with horns up to 145 cm in length (average maximum length is about 127 cm) and with a basal circumference between 37 to 50 cm. Tips often broken. Size of neck ruff said to be inversely related to horn size (MacDonald 1984).

Age classes have not been established for argali. These should be based on known–age animals (see Geist 1971 for guidelines).

Ibex (*Capra ibex sibirica*)

Based on Schaller (1977:104) (Mountain Monarchs, University of Chicago Press)

The ibex is a high altitude goat found in the drier parts of Central Asia and extending into Europe. Ibex distribution overlaps with that of snow leopards. Usually only found in areas with cliffs and very steep mountain slopes. Like all ibex, the Asiatic ibex have a strong predilection for the steepest terrain and are excellent climbers, though easily killed by hunters in the winter when deep snows hinder their movements. They spend summers at 4,000 m or more if grassy hanging meadows are available, and their escape is always to cliffs. May feed on nearby gentle slopes. Rutting occurs in December to January, with young being born in June or July.

Lamb–of–year (less than 1 year of age): Only found in female or nursery herds. Small, wooly, remaining close to mothers.

Yearling (1 to 2 years): Males resemble females except for a darker pelage. Unlike older males, they lack a saddle patch, their beard is small, and horn length is 18 to 30 cm. Females are small, with short, thin horns.

Adult female: Stands 67 to 74 cm at the shoulder, weighs 40 to 56 kg and has horns that are about 29 cm in length on average.

Adult male: Unmistakable colorful dark brown goat, with a distinctive beard and silvery saddle. It stands some 92 cm high and weighs about 70 kg with scimitar–shaped horns up to 145 cm long. Average horn length is about 70 cm.

Horn growth for the first 3 years is 10 to 13 cm per annum. A rough means of aging ibex at a distance, when annual rings cannot be distinguished, is to count the number of prominent ridges along the front of the horn. According to Schaller, approximately two ridges per year are grown when the ibex is between the ages of 2 and about 9 years. He reported the mean number of ridges for the following ages, based on 87 trophies, as:

2–3 years	5.0 ridges
3–4 years	6.6 ridges
4–5 years	8.3 ridges
5–6 years	10.4 ridges
6–7 years	12.2 ridges
7–8 years	13.4 ridges
8–9 years	16.4 ridges
9–10 years	17.7 ridges
10–11 years	17.8 ridges

Class I male (about 2.5 years): About the same size or larger than females, but only a few males have a silvery saddle. Horn length varies between 30 to 33 cm.

Class II male (about 3.5 years): Larger with longer horns.

Class III male (4.5 years): Exhibit adult pelage.

Class IV male (5.5 years or older): Horn length is at least 64 cm.

Thorold's (white–lipped) deer (*Cervus albirostris*) and MacNeil's deer (*C. elaphus macneili*)

From Whitehead, G. K. 1972 (Deer of the World, Constrable Press, London).

Thorold's deer: Also known as the white–lipped or Przewalskii's deer. Standing about 122 cm at the shoulder, with withers somewhat lower than the rump. Head has a somewhat flattened appearance. The Thorold's deer has a brown coat with a creamy belly and a white nose, lips, chin and throat, with another white patch near the ears. Its ears are narrow and lance–shaped and it has a very short tail. The hooves are high, short, and wide like that of cattle. The antler beam is up to 130 cm in length and branched. It lacks a bez tine, thus showing brow, tray and fork tines (8–pointed). May appear to have a withers hump, due to reversal of hair. Found in shrub and lightly forested areas, but generally lives above timberline for most of the year in Qinghai (i.e., above 3,600 m).

MacNeil's deer: Muzzle is entirely brown.

Antlers usually up to about 120 cm, but longer specimens known. Weight of adult male about 76 kg. Adult male stands about 130 cm at the shoulder. Generally five points on each antler (i.e., antler is 10–pointed), showing brow, bay, tray and fork. A bez tine is present (i.e., a second forwardly projecting tine which hangs over the face, also known as a bay tine, and branching off immediately above the first which is called the brow tine). Antlers shed in April, growing again in summer, with the velvet having been shed by late September for the October/November rut.

Sex and Age Classification:

Adult females (hind): Obvious, since they lack antlers and are much smaller than males.

Calf (young–of–the–year): Small size, with hind groups.

Males (stag): Males grow and shed antlers annually. Form bachelor groups, especially outside of the rut. Dominant stags chase off other males, and keep "herd" on breeding–age hinds.

Class I (young stag): Noticeably smaller; antlers short with three or fewer tines.

Class II (mature stag): Fully grown (more than four years of age) males with well–developed 10–point antlers, well–developed chest, and sturdy neck.

Note if antlers are present; if so are they in velvet or hard. Knobs may be present in males which have shed their antlers or in calves entering their second year.

Markhor (*Capra falconeri*)

The Astor and Kashmir markhor fall within the flare–horned group of markhor according to Schaller and Khan (1975). The markhor is a goat of low altitudes (Schaller 1977). Its main requirements consist of cliffs in areas with little precipitation, deep snow especially being avoided. Although markhor may ascend to over 4,000 m during summer months, they require terrain below an altitude of about 2,200 m in which to spend the winter, and are absent where the valley floor is above 2,200 m even if suitable cliffs are present. While they are seldom exposed to temperatures below –10°C, they can tolerate summer temperature in excess of 45°C.

The following age classification for the Kashmir markhor is derived from Schaller and Mirza (1971).

Adult male: Sexual dimorphism is well pronounced in markhor, with males weighing nearly twice as much (up to 104 kg) as females and sporting long, spiraling horns up to 165 cm in length (in trophy class individuals). Stocky, with massive shoulders, broad chests and powerful legs, standing between 95 and 100 cm at the shoulder. A dark flank stripe runs from the nape to the flank separating the brown and gray body from a nearly white abdomen. Fully–grown males have a long, flowing ruff of white to gray hair on chin, shoulders and chest, and often also whitish tufts on each foreleg and stifle. Both sexes have a small white rump patch, bordered by black.

Yearling male and female (aged 1.5 years): Resemble adult females, but are slightly smaller. Their 30 cm long horns are darker in coloration, longer and somewhat broader. Yearling females are smaller than male yearlings, with a short muzzle and horns which are less than 12 cm in length.

Subadult or Class I male (2.5 years): Same size as adult female with horns up to 45 cm long and a pelage that is dark brown with a grayish neck. They lack a ruff, however.

Young adult or Class II male (3.5 years): Similar to Class I, but with the addition of a fringe of white hair on the forelegs and across the chest – the beginnings of a ruff. Horns may be over 50 cm in length.

Adult or Class III male (4.5 – 5.5 years): Possess a prominent black beard and a long ruff of white to gray hair flowing from the neck, chest and upper parts of the forelimbs. There may be a vertical slash of almost black hair by the shoulder and before the haunch, and a conspicuous light–colored patch on the thigh. The horns are often over 75 cm long.

Adult or Class IV male: This age class shows a very well developed ruff and beard, along with horns which are strikingly long, and a pelage that is more gray than brown (except for the black face and upper parts of the legs).

Adult female: Lightly built, lacking the well–developed beard and horns of the males, but sporting a short, wispy beard. Horns are thin and spiraling, up to about 25 cm long. General coloration is fawn to rusty–colored, with a white belly and a dark line running along the back and another along the neck from chin to chest.

Young–of–the–year: Considerably smaller than a yearling, all lambs stay close behind their mothers until they are more than 6 months of age. Their horns very short (less than 7 cm in males and even shorter in female young–of–the–year). It is difficult to distinguish between male and female lambs until they are 6 months or older.

Himalayan Tahr (*Hemitragus jemlahicus*) (from Schaller 1977; Jackson and Ahlborn 1986)

Himalayan tahr inhabit a narrow strip along the southern flanks of the Himalaya range, penetrating into a few inner gorges, a range that is now highly fragmented. A large animal, which has been called the quintessential goat, for it prefers to inhabit the steepest of precipices. Found between elevations of 1,200 and 4,500 m. It is mostly associated with forested habitat, although some populations in Nepal live permanently in alpine scrub and grassland. Males have short but massive horns, and there is less difference in size between male and female than other caprids.

Lamb–of–year (less than 1 year old): Lambs are obvious by their small size and other juvenile features, their pale grey pelage and their behavior (e.g., staying close to the nanny).

Yearling (1 to 2 yrs): Yearlings are intermediate in size between lambs and adult females. Male yearlings are smaller than an adult female tahr. They have a small ruff in some cases, a lighter colored leg and muzzle, and thicker horns than that of a female. By contrast, female yearlings are smaller yet have short, thin horns.

Adult female: Stand about 80 cm (31.5 in) at the shoulder and usually weigh less than about 36 kg. They show a dark side and dorsal stripe, with a yellowish brown neck. The horns are slender and shorter than those of a Class I male, but obviously thin and frequently malformed. The neck is long, dark brown or pale brown depending on the season. A few females may have a ruff, and their build is quite stocky compared to other wild goats.

Class I male (2 to 3 yrs): Animals of this age class are about the same size as adult females, but sport a conspicuous neck ruff. Their horns are thick, smooth and yellowish, rather than dark and corrugated like those of older males.

Class II male (3 to 4.5 yrs): Distinctly larger than an adult female, but not as robust as a fully grown male. The ruff is shaggy, with a short mantle of hair on the back. The pelage is a rich brown–blackish coloration. Horns are obvious, dark and corrugated.

Class III male (> 4.5 yrs): Unmistakable – a large and robust animal with a voluminous coppery–colored mantle hanging down to its flanks, thigh and knee and sporting a light, straw–colored neck ruff that waves in the wind. The rump is rusty in color, the legs dark, and the face is narrow and black in appearance. The horns are about 37 cm (14.5 in) in length; they are dark and corrugated with a distinct frontal keel. A fully grown male stands between 91 and 102 cm (35 to 40 inches) at the shoulder and weighs about 90 kg.

Behavioral characteristics are also helpful in separating age classes: For example, older males tend to stay in all male groups outside of the rut. However, be alert for Class I males which tend to remain with the female herds. Like other ungulates, male yearlings are more apt to indulge in aggressive behavior. Yearling males can be very difficult to tell from adult females, especially in late winter or early spring. Be sure to take a close look at horn details.

Appendix C. Table of random numbers between 1 and 1,000.

490	934	431	819	617	683	479	890	486	290	946	244	60
190	720	478	977	890	567	762	695	676	871	36	121	14
540	808	259	969	960	614	26	677	749	315	614	71	555
766	628	635	597	258	612	735	630	552	562	65	417	28
878	524	315	459	895	714	224	73	676	350	923	821	654
562	777	514	324	969	952	441	385	58	201	261	571	863
530	724	461	113	57	339	402	24	145	767	778	774	567
170	682	106	613	907	79	561	94	507	984	1	655	416
119	348	686	606	313	949	640	574	45	218	317	361	914
207	784	940	846	864	645	275	254	762	656	657	310	296
556	761	997	923	851	567	243	873	854	5	478	314	616
52	337	677	656	977	359	13	751	576	811	414	368	582
92	503	510	337	906	603	834	584	555	836	681	895	716
547	981	288	356	179	888	194	789	380	353	333	74	104
55	792	543	640	297	74	306	534	382	545	201	912	364
819	361	866	272	995	406	154	656	526	78	934	938	376
707	777	278	588	117	813	510	357	259	348	572	353	868
229	941	536	503	828	435	960	459	402	290	682	994	664
144	811	718	362	911	90	925	879	50	890	659	743	203
398	336	487	336	587	432	143	192	495	134	635	592	838
144	119	757	200	536	564	552	304	356	349	705	505	754
610	836	931	243	572	875	149	825	517	311	598	669	241
195	136	472	643	418	702	953	198	115	839	192	816	49
683	375	70	823	829	581	815	828	934	921	396	279	588
578	851	928	82	218	42	159	376	489	515	243	388	66
2	843	64	485	225	331	5	692	706	922	674	860	486
246	763	962	804	727	963	894	415	9	852	862	525	990
771	415	744	613	189	791	949	14	564	887	4	764	295
304	872	413	594	272	397	882	155	552	595	85	266	289
176	234	565	818	791	839	476	432	772	949	375	909	351
69	470	104	426	794	44	594	583	935	786	541	779	290
842	501	329	128	665	11	392	706	907	890	378	404	847
932	825	436	24	125	634	306	475	632	957	317	921	383
338	468	517	1	500	442	467	326	743	776	902	742	409
421	45	707	266	655	560	594	320	809	31	24	405	84
301	245	111	343	470	690	956	743	667	202	21	840	570
87	967	118	752	649	138	846	105	450	586	758	826	801
582	300	464	642	490	811	111	542	322	647	252	68	312
779	732	872	574	673	909	1	622	283	862	979	225	784
530	364	537	479	387	221	762	71	35	474	552	603	609
760	225	641	470	52	53	916	787	391	228	262	490	802
539	736	607	218	608	923	611	99	294	255	696	127	876
620	768	68	559	819	253	500	215	318	535	276	992	11
371	984	816	409	641	749	461	541	684	268	939	352	336

264	674	600	567	230	505	428	696	3	84	203	20	699
714	354	552	387	572	110	934	933	572	623	659	110	26
21	611	71	467	504	475	844	369	564	436	982	97	588
193	128	163	590	907	521	487	775	32	523	774	241	388
440	420	564	531	982	400	372	94	559	239	317	713	484
749	308	733	235	472	505	427	924	301	989	746	88	576
144	224	672	526	285	255	958	852	518	333	90	733	896
149	557	161	57	807	707	286	316	43	50	729	642	693
551	621	665	991	267	287	965	747	53	737	818	201	990
582	53	339	901	357	707	129	497	188	196	386	89	596
892	517	836	731	467	91	497	439	190	508	758	919	643
992	882	487	776	8	350	169	70	631	934	15	211	602
29	134	745	743	427	517	580	383	732	983	464	464	524
253	581	389	744	369	192	342	139	991	814	334	654	832
789	821	732	206	427	898	467	152	776	343	613	576	830
553	635	976	414	781	872	227	759	459	438	487	32	977
995	24	372	879	47	674	475	254	22	891	993	757	624
834	732	291	966	689	776	745	968	823	982	28	996	428
878	983	803	627	175	532	290	147	561	637	426	557	481
736	701	768	312	627	317	483	869	669	773	734	322	851
234	903	760	880	868	35	16	586	467	944	96	234	391
708	862	1	382	252	170	113	189	703	696	501	624	928
456	815	946	932	444	35	391	929	39	703	185	320	417
183	458	801	944	479	351	179	335	864	845	273	930	12
655	296	9	202	332	240	919	472	31	100	863	830	531
35	864	401	269	933	516	427	65	529	40	380	31	282
208	919	645	739	981	437	193	316	987	58	382	657	125
35	505	458	377	574	680	904	947	358	836	694	624	633
253	408	353	992	564	923	708	506	873	200	357	690	65
75	458	939	203	887	357	917	750	385	585	156	814	372
313	733	208	768	20	882	116	304	974	227	51	650	523
305	333	213	436	276	774	955	199	521	231	391	878	792
525	375	247	630	865	327	403	190	463	318	752	202	348
265	987	606	97	90	526	353	95	857	943	759	328	249
921	48	655	887	199	681	939	792	544	984	853	781	167
348	827	173	428	26	651	120	84	744	646	204	674	501
204	16	719	869	645	976	154	936	638	207	190	412	849
235	54	251	145	988	573	615	294	792	211	122	743	101
914	609	582	227	717	301	643	800	47	55	259	864	194
194	194	218	710	182	907	798	53	328	573	109	528	605
508	499	183	477	552	664	314	185	960	779	304	387	830
874	153	754	352	891	420	343	972	645	792	269	104	671
996	352	277	401	779	487	585	632	870	96	632	222	46
291	652	935	650	582	352	129	135	353	892	805	736	651
328	855	459	176	308	687	183	957	497	277	52	818	879
98	733	397	430	97	324	217	79	368	817	117	756	611
55	472	776	199	667	393	617	135	532	483	740	284	779
846	20	795	47	203	105	565	942	306	770	807	571	596

941	815	21	369	887	997	402	871	860	569	303	897	947
776	17	453	669	22	993	162	691	488	170	5	251	4
522	950	293	105	486	125	509	987	896	219	13	512	502
561	801	751	481	437	481	28	48	28	297	400	919	955
131	396	198	450	634	462	747	432	138	737	334	286	316
470	525	77	641	762	593	523	592	811	830	674	583	43
955	802	121	344	558	761	789	691	466	990	582	354	230
301	149	165	839	295	799	615	985	277	979	576	585	760
308	400	805	235	686	162	786	134	66	876	174	704	677
430	52	266	355	267	129	13	230	908	30	184	369	606
857	119	871	847	211	643	847	671	518	190	900	613	224
11	799	756	997	582	961	486	815	946	932	804	254	424
5	754	453	829	812	370	654	679	542	781	453	450	227
996	587	451	211	29	436	965	419	330	464	999	338	191
429	690	653	327	446	477	929	681	537	441	489	433	588
909	836	977	384	847	405	376	48	734	403	242	839	383
834	360	506	952	521	662	912	351	362	939	183	886	475
347	399	15	862	983	757	214	891	196	518	230	228	475
770	748	563	381	700	551	365	412	203	911	113	801	686
761	910	993	930	634	814	907	358	829	964	752	708	116
793	879	430	544	50	312	240	345	763	4	647	697	154
256	279	783	862	13	656	620	555	591	270	766	956	453
747	144	581	289	714	107	158	995	907	488	425	260	670
791	251	193	615	363	662	599	349	885	500	834	16	911
508	619	25	180	597	912	438	602	156	673	312	461	438
280	671	275	684	262	737	62	79	952	740	782	675	915
513	991	742	936	224	678	769	803	532	586	878	230	167
504	602	892	616	857	475	281	356	342	839	326	133	476
783	444	751	598	906	866	973	447	142	631	442	836	367
554	179	280	480	151	409	424	151	344	617	849	65	723
426	578	189	17	959	917	736	740	981	152	453	126	925
489	917	657	775	330	413	301	2	901	642	490	892	263
558	392	156	386	57	194	60	64	671	995	831	405	154
108	679	42	702	781	686	887	522	313	462	647	978	146
834	97	471	470	190	232	456	927	689	151	502	192	958
992	450	428	886	376	531	718	12	676	908	835	158	114
146	404	128	627	78	824	0	623	968	425	822	973	811
391	30	105	420	149	747	565	704	742	109	992	295	214
968	487	182	784	813	271	272	462	104	595	750	717	493
796	578	348	20	263	823	398	503	341	205	797	937	579
348	348	462	48	736	276	277	595	563	823	552	869	239
402	104	610	966	338	744	163	438	57	187	17	192	82
151	769	916	327	324	865	566	544	983	699	489	841	585
346	581	57	510	613	907	271	482	866	598	510	140	680
942	923	571	824	261	963	449	640	363	748	250	73	684
421	57	128	239	732	829	784	983	353	438	53	369	991
184	824	16	602	825	430	474	964	271	789	305	560	935
535	75	967	622	365	376	512	11	294	991	704	413	331

593	49	524	923	287	240	633	96	734	614	788	621	195
163	612	22	804	394	592	720	844	396	355	169	835	848
623	201	306	257	715	890	211	276	711	389	751	420	343
552	812	242	300	763	579	485	484	823	361	438	73	284
996	180	430	97	196	834	374	492	695	842	35	481	514
702	470	719	232	806	209	984	167	172	853	390	908	141
253	203	248	331	939	303	141	494	775	336	509	976	207
977	599	424	88	488	431	952	754	41	325	456	926	41
811	291	551	227	865	304	428	46	319	660	125	627	634
473	722	988	983	2	700	899	579	141	910	3	40	514
208	643	702	293	790	802	168	295	646	834	715	651	267
902	845	490	845	657	561	389	381	72	189	334	439	939
711	782	826	139	881	704	863	48	487	772	928	946	565
847	293	220	111	658	975	135	785	781	896	772	711	321
517	739	804	936	321	403	88	834	185	237	261	135	748
700	112	809	314	906	956	60	444	157	799	485	26	649
121	540	635	160	793	34	59	4	398	133	142	499	80
362	577	440	836	551	499	451	774	336	769	72	865	956
703	92	733	769	103	426	161	445	952	704	407	809	994
763	867	415	15	340	0	189	251	734	729	760	567	560
364	819	296	995	866	666	883	97	402	587	762	883	368
482	159	764	161	77	387	269	748	873	757	13	524	501
263	429	995	219	50	440	773	781	250	895	806	12	843
5	639	29	821	397	390	885	560	327	552	586	997	614
88	506	280	65	423	545	299	398	507	413	435	341	182
549	232	590	238	715	757	623	777	815	646	311	831	124
241	525	569	674	814	406	789	696	938	633	797	676	713
690	596	998	312	411	151	257	655	274	669	291	603	871
562	60	878	266	659	689	368	987	676	580	914	63	870
363	68	576	999	142	972	786	905	882	521	494	497	392
914	480	25	164	975	442	960	910	492	193	588	640	150
866	250	71	787	428	750	875	414	101	934	60	366	861
224	172	805	786	512	319	404	924	774	253	611	838	360
548	650	200	255	391	122	622	186	100	589	708	381	422
289	276	486	245	10	375	496	252	546	662	671	687	301
453	795	687	526	580	42	514	196	89	63	673	473	520
577	945	973	426	974	638	736	719	767	844	974	987	0
634	327	438	278	254	859	446	903	304	414	183	703	547
920	279	24	358	770	13	656	37	906	521	595	95	566
801	295	196	669	45	514	844	182	324	551	966	842	244
292	136	420	584	933	67	346	741	543	674	178	234	831
524	103	884	568	823	435	959	928	315	704	166	110	907
265	108	865	733	972	798	976	859	765	373	945	262	402