

*from Russia and Afghanistan during the winter rut. Ibex occur primarily in the western part of the reserve and blue sheep—the most abundant wild ungulate—in the eastern and southeastern parts. The two species overlap in the area of contact. Counts in selected mountain blocks totalling 1445 km² within the reserve revealed an average wild ungulate density of 2–34 animals km⁻². Snow leopard were rare, with possibly 50–75 in the reserve, as were wolves and brown bear. The principal spring food of snow leopard was blue sheep (60%) and marmot (29%). Local people have greatly decimated wildlife, killing wild ungulates for meat and predators to protect livestock. Overgrazing by livestock and overuse of shrubs for **fuelwood** is turning this arid steppe habitat into desert. There **is need to place restraints on** the killing of wildlife, to introduce appropriate¹ technology such as solar cookers, and to encourage occupations that remove people from the land—trade, manufacture of handicrafts, and activities associated with tourism.*

INTRODUCTION

Taxkorgan Natural Reserve, established in 1984, comprises approximately 14000km² of terrain in the southwest corner of China's Xinjiang Uygur Autonomous Region where the borders of China, Pakistan, USSR, and Afghanistan meet. The reserve is mountainous, about half of it 4500 m and above in elevation, including the northern flanks of the Karakoram, the western edge of the Kunlun, and eastern rim of the Pamir mountains. The southern boundary follows the Pakistan border eastward until just past K2 (Chogali), at 8611 m the world's second highest peak. For part of this border the reserve is contiguous with Pakistan's Khunjerab National Park. 2200km² in size, which was established in 1975 (Schaller, 1980). The southeast portion of the reserve is so remote that few foreign expeditions have penetrated it (Younghusband, 1896; Shipton, 1938), whereas the west has been an international travel route for centuries. Flat and in places more than 5km wide, the Taxkorgan Valley (the Taghdumbash Pamir on old maps) was part of the ancient Silk Road which continued into the Chalachigu Valley and over the Mintaka Pass into Pakistan. Since the late 1960s a highway has connected China and Pakistan via the Khunjerab Pass, a route opened to tourism in 1986. The northern and northeastern reserve boundary traces various tributaries of the Yarkant(Yeeheng) River (Fig. 1). As part of a project to assess China's high altitude wildlife resources, we made surveys in and around the reserve from June 1985 and from 14 June to 11 July 1986. Our principal aim was to determine status and distribution of the large ungulates and carnivores for whose protection the reserve was mainly established: Marco Polo sheep *Ovis timmon poll*, Asiatic

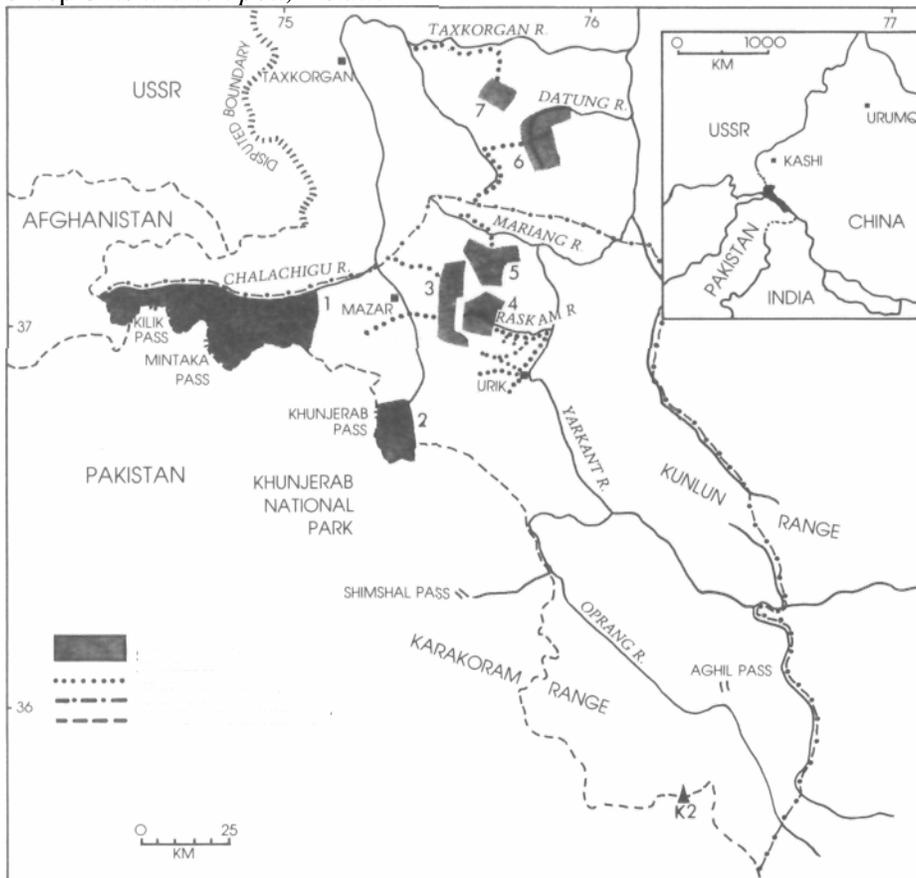


Fig. 1. The Taxkorgan Reserve showing transsect routes and survey areas.

ex *Capra ibex*, blue sheep *Pseudois nayaur*, brown bear *Ursus arctos*, wolf *Canis lupus*, and snow leopard *Panthera unda*.

STUDY AREA

The westernmost 2600 km² of the reserve represents mainly *pamirs*—broad valleys and steeply rolling hills above an elevation of 3500m flanked by rugged ranges (Fig. 2). Between the eastern rim of the Taxkorgan Valley and the Yarkant River is a chaotic jumble of mountains, broken cliffs, and sharp ridges cut by desolate gorges down which torrents rush. Near the junction with the Yarkant River, the Raskam, Mariang and other drainages lie below 3000m in elevation, the lowest part of the reserve (Fig. 3). On the eastern



Fig. 2. The steeply rolling hills along the southern flanks of the Chalachigu Valley represent typical Marco Polo sheep habitat (skull in foreground); the rugged terrain is ibex habitat (4200m, 18 June 1986).

bank of the Yarkant are the Taxkuzuke Mountains, a discrete, rough range covering about 3200km². The south-eastern section of the reserve, about 5200 km² in extent, lies mostly above 4500 m, and includes the Karakoram with its extensive glaciers, the Aghil Range, and the Oprang (Shaksgam) Valley, a region well described by Shipton (1938).

The climate is cool and dry. The average monthly minimum at Taxkorgan town (3090m) in 1984 was -16° to -17°C during the coldest months of December and January, and the average daily maximum reached 22° to 23°C during the warmest months from June to August. Only 75-4mm of precipitation fell, 81% of it between May and September.

Most terrain is too high or arid to support much vegetation. Below an elevation of about 3000- 3200m are usually cliffs, scree, sand, and silt, a desert so dry that few plants thrive except along streams. The only native trees in the reserve are found in low-lying valleys, willow *Salix* and tamarisk *Tamarix* below 3400m, and cottonwood *Populus* and birch *Betula* below

3300m, a few trees being as tall as 10m. Wildlife seldom uses these low elevations except that in winter some blue sheep and ibex may descend in search of forage. At 4400 m, near the upper limit of vegetation, plants grow



Fig. 3. Birren slopes border the Yarkani River near the month of the Raskam Valley (2700m, 30 June 1986).

mainly along seepages and rivulets, and at 4500m soil has usually given way to rock, although a hardy *Rhodiola*, *Saussurea*, *Tanacetum*, and *Saxifraga* may be found as high as 4600-4700m, above which wildlife cannot find sustenance. Two principal ungulate habitats occur between 3000 and 4500 m in elevation: (1) Along streams, rivulets, moist depressions and other sites with sufficient water grow sedge meadows, dominated by *Carex* and *Kohresia* and others, and also grasses and forbs (*Primula*, *Pnientilla*, *Pedicularis*, *Polygonum*, *Leontopodhun*). (2) Flats and slopes have an alpine tundra vegetation, the ground bare except for scattered low shrubs (*Artemisia*, *Acantholimon*, *Caragana*, *Astragalus*), grass tufts, and forbs such as *Oxytropis*.

The vegetation has been greatly modified by human and livestock use. Four communes and a breeding farm, totalling about 7750 Kirgiz and Tajik people and 70000 head of livestock, used the reserve at least seasonally in 1985 (Table 1). Of the livestock, about 80% represents sheep and goats and 20% large animals (donkey, horse, cattle, camel, yak). Unusually heavy snows during the 1985-86 winter resulted in the death of 10-12% of this livestock, mostly in the western part.

Where land is flat and irrigation possible, barley and a few other crops are

Human and Livestock Populations of Communes in which Wildlife Surveys were Conducted

<i>Cfijmune name</i>	<i>Main area</i>	<i>No. people</i>	<i>No. sheep and goats</i>	<i>No. large animals*</i>	<i>Total livestock</i>
Taxkorgan	Chalachigu valley	2969	19048	4276	23322
Tisnap	Khunjerab valley	1541	—	—	11570

Mazar" Depter Ma Hang Calling* Kukshmk ⁶	Area north of Khunjerab Raskam and SW reserve Manang River drainage Dalung River drainage Lower Taxkorgan River
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side reserve. 'Yak, cattle, camel, horse, donkey.

grown. Most fields are at low elevations though a few occur as high as 3900 m. Potential agricultural land is so scarce that, for example, only about 12 families have been able to establish themselves in the whole Raskam drainage. Where available, trees are cut for roof construction and fuel; an occasional juniper *Juniperus* clinging to a remote cliff suggests that it is a survivor of a species that was once common below 3500m. Where trees are unavailable, low shrubs such as *Artemisia* and *Ephedra* are dug up by the roots for fuel, a practice which, together with heavy livestock grazing, has turned low-lying slopes and valley flats to desert. All accessible areas up to the vegetation limit are grazed by livestock. Some areas are used only seasonally; the Taxkuzuke Mountains, for instance, are mainly winter range. However, good pastures, such as those in the western part of the reserve, are heavily grazed all year, except when snow forces livestock to shift in winter, either downhill or from north to south-facing slopes. The wild ungulates must thus share all their prime habitat with domestic ones.

METHODS

With travel in most of the reserve limited to horse, yak, or camel during the few months each year when passes are snow-free and streams not in flood, we surveyed only in the western half to which access is easier than the eastern; in addition, several areas just north of the reserve were visited. Two kinds of survey were conducted: transects, often along valleys, during which we checked on the status of wildlife by looking for spoor and interviewing local people; and counts of wild ungulates and quantification of carnivore spoor

in selected mountain blocks. In the latter, an attempt was made to obtain a total count of animals by surveying all drainages and scanning all slopes within areas that varied from 75 to 850km² in size. Survey blocks were not selected at random. All areas that might harbour Marco Polo sheep were checked (Areas 1-3 in Fig. 1), and one block in each of 4 major drainages (Areas 4-7) was selected.

On spotting an ungulate herd, we counted the number of individuals and attempted to determine age and sex, the latter often unsuccessful because animals usually fled as soon as they detected a person. The horns of male Marco Polo sheep, blue sheep, and ibex were often found, especially around camps of pastoralists. Annual growth segments were measured and age at death was determined by counting growth rings, as described by Bunnell (1978), a method accurate for males but not females (Geist, 1966).

Carnivore tracks are often difficult to detect without snow cover, but some spoor is conspicuous. Brown bears excavate burrows in pursuit of marmots *Marmota caudata*. Snow leopards make characteristic scrapes—by raking hindpaws on the ground—at conspicuous locations such as on mountain passes and at the base of cliffs (Schaller, 1977; Jackson & Ahlborn, 1984; Million, 1984). To ascertain relative snow leopard abundance, we counted all scrapes and quantified those in three types of locations, at passes, along major ridge crests, and in valley bottoms with a width of about 25 m or less to permit easy search of both sides. Travel distances on ridges and in valleys were estimated. Food habits of carnivores were determined by analysing

content of droppings. Snow leopard may defecate near a scrape. When not associated with a scrape, the cat's droppings can be confused with those of dog or wolf where these canids also occur. Consequently droppings were not collected in areas with much human activity, and droppings of questionable origin were not used in our

analyses. Prey remains in droppings were identified by the distinctive colour and texture of hairs and by the presence of hooves, claws, and other remains. Most droppings contained only one prey item; if more than one was present, the percentage of each was estimated. The results are expressed in total per cent occurrence rather than frequency of occurrence, a method that reflects the amount of minor prey items more accurately.

Results Ungulates

Three wild ungulate species inhabit the reserve. A fourth, the wild ass

Equus hemionus kiang, once occurred along the upper Yarkant and Oprang rivers

(Shipton, 1938), but, according to local people, was last seen during the 1950s.

Marco Polo sheep

An inhabitant of broad valleys and rolling hills in the Pamirs, the Marco Polo sheep with its long, flaring horns, first described by Marco Polo in 1273, has been one of the world's most coveted trophies among western hunters for over 100 years (Cumberland, 1895; Roosevelt & Roosevelt, 1926). Although this argali sheep may not deserve subspecific status, it being similar to other so-called argali subspecies to the northeast in the Tian Shan (see Scrmller, 1977), we retain here its customary classification. Most of its range lies in the Pamirs of Russia (Heptner *et al.*, 1966), where little about its current status is known. The animal is also found in the Wakhan Corridor of Afghanistan where Petocze; *al.* (1978) estimated at least 2500 sheep in 1973 but no recent information is available. Suitable Marco Polo sheep habitat in Pakistan is limited to a small area around the Kilik and Khunjerab passes bordering China. In the past, many animals moved seasonally between the two countries (Schaller, 1977). As recently as 1959 an American hunter saw a herd of 65 males in the Khunjerab area (Clark, 1964). However, with the construction of the Karakoram highway in the 1960s hunting became intensive. Monthly counts from 1978 to 1981 seldom revealed more than 60 animals on the Pakistan side of the border (Rasool, 1981), and by 1984-86 the population had dropped to 15-20 animals (G. Rasool. pers. comm.).

In June 1986 we surveyed Marco Polo sheep in the Taxkorgan Reserve (Fig. 4). Work in the Chalachigu Valley was restricted to the reserve, but since most suitable sheep habitat was within our 850 km² survey block and we were able to look over much of the northern half of the valley, we could assess the status of the sheep in the area as a whole. In the southern half of the valley 1, 1, about 12,13, and 21 sheep were seen, and in the northern half 8 and 33, a total of 89. No doubt some animals were overlooked, but the total population at this season in the Chalachigu Valley was probably below 150 animals.

Most of the observed animals were females and yearlings; no male was older than 3 years. Yet 80% of the horns of males found

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years of age (Fig. 5), longevity in the species seldom exceeding 10 years (Schaller, 1977; Petocz *et al.*, 1978).

Similarly, Lee (1986), who hunted sheep in the area, saw no large males in October 1980 and May 1981; however, he observed them in December 1980 (and shot 3). The evidence, therefore, suggests that adult males spend much of the year in neighbouring Russia and Afghanistan, joining the females in China mainly during the rut, which is in December-January (Heptner *et al.*, 1966). The scarcity of trophy-sized males, or for that matter of alt Marco Polo sheep, in China was already noted by Roosevelt & Roosevelt (1926). Clark (1964) and other early western hunters.

Lee's (1986) casual observations convey the impression that females and subadults were more abundant in 1980-81 than at the time of our survey. Hunting pressure has been heavy in recent years judging by Marco Polo sheep remains around herders' camps. Furthermore, heavy snows during the 1985-86 winter caused mortality. In one valley we found the remains of 12 sheep which had apparently died of malnutrition, 5 young and 7 yearlings (2 males, 5 females). Poor winter nutrition may also have affected reproduction in 1986; only one young was observed, on 19 June, although most parturition occurs in early June, at least in Afghanistan (Petocz *et al.*, 1978).

No sheep sign was found on the Chinese side of Khunjerab Pass, and persons at the road maintenance and military posts there confirmed that none remain; the few animals on the Pakistan side of Khunjerab Pass now appear to be isolated. Sheep persisted along the eastern edge of the Taxkorgan Valley, east of Mazar, as recently as 5 years ago, according to herdsmen, but we failed to find any (Table 2). Suitable Marco Polo sheep habitat also extends north of the reserve in a narrow band near the Russian border (Fig. 4). Animals are said to enter China northwest of Taxkorgan

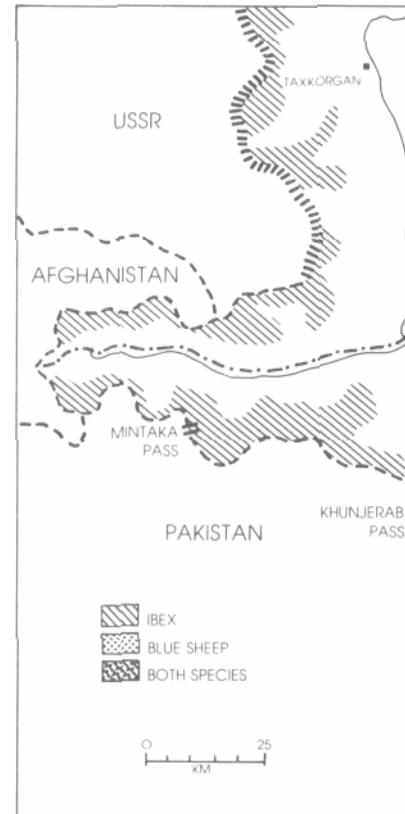
TABLE 2
Density of Wild Ungulates in the Survey Blocks

Area'	Size of area' (km ²)	No. blue sheep ¹	No. ibex	No. Marco Polo sheep	Total animals km ⁻²
1. Mintaka	850	—	13	48	0-1
2. Khunjerab	140	—	0	0	0
3. Mazar	185	—	100	0	0-5
4. Riiskam	ISO	31	—	—	0-2
5. Mariang	120	265	33	—	2-5
6. Dalung ¹	140	0	196	—	1-4
7. KukshihV	75	—	177	—	2-4

Numbers correspond to those in Fig. 1. 0, the species is or was present but was not observed; —, the species has not been reported in the area. Located outside reserve.

town, and horns in the valley west of 7546m-high Mustag Ata attest to recent stragglers in the area. Although an occasional isolated animal or small herd may still be found in parts of (the animal's former habitat, the last known viable population in China is now confined to the western part of the Chalachigu Valley and even its existence seems to depend on the seasonal immigration of adult males from Russia and Afghanistan.

Ibex
Favouring grazing grounds on steep slopes within



300m Fig. 6. Distribution of ibex of precipitous terrain, ibex have much suitable habitat available in the Taxkorgan Reserve. However

er, the species is found only in the western and northern parts (Fig. 6). Densities differed greatly in the survey blocks (Table 2). None were observed in the Khunjerab area. Only 13 ibex were tallied in the large Mmtaka block (0-02 ibex km²), even though 'Mintaka' means "Place-of-1000-ibex" in Kirgiz. While a few herds no doubt were missed by us or were seasonally on [he Pakistan side of the border, the scarcity of animals becomes evident

when compared to a count in the ecologically similar Horendaban Mountains, a subrange of the Tian Shan 1000 km northeast of Taxkorgan. There we tallied 716 ibex (and 63 argali) in a 750km² survey block (0-95 ibexkm²) during May 1986. In the Taxkorgan area, the highest ibex densities were found in the three most northern blocks both inside and outside of the reserve (average 1-3 ibexkm²). The data show that ibex have been hunted close to extinction from Khunjerab westward and that they survive in moderate numbers in the northwestern part, possibly fewer than 1000 remaining in the reserve.

All ibex in 11 herds, ranging from 3 to 74 animals in size, were classified in 1985. There were 78 males, 73 females, and 50 young (11-12 months old), a young:female ratio of 68:100. The first newborn of the 1985 season was observed on 15 June.

The horns of 136 males were found, most from animals killed by hunters. Fifteen per cent of the animals were considered to be subadult (1 -4 years old), 73% in their prime (4-9 years), and 12% past prime (9-12 years) with heavy tooth wear, the infundibuli worn off the first molar (Fig. 5). Nutrition affects horn growth, animals in areas with high-quality forage producing annual horn segments of greater average length than animals dependent on low-quality forage (Nievergelt, 1966). Horn growth can therefore provide a rough indication of habitat conditions when comparing areas. Males in the Horendaban Mountains seemed to have longer (and more flaring) horns than those in Taxkorgan, and measurements confirmed this (Fig. 7). The Horendaban animals grew significantly more horn each year than the Taxkorgan ones, primarily between the ages of 3-9 years ($p < 0.01$) but also in other years ($p < 0.05$). The alpine grasslands in the Horendaban

Mountains were clearly of higher quality than those in the spartan Taxkorgan environment,

Blue sheep

Blue sheep, in spite of their name, are most closely allied to goats (Schaller, 1977). their habitat requirements similar to those of ibex. The species occurs from the eastern rim of the Taxkorgan Valley in all ranges to the east and southeast of the reserve, according to local informants and travellers (Shipton, 1938). We found blue sheep fairly abundant only in the Mariang block. In the upper Raskam, a block lying wholly above 4000m, only one herd was observed (Table 2). This area, as others of similar elevation, offers suitable grazing mainly near valley bottoms- -which are either deep in snow or much used by livestock. The lower Raskam is so precipitous that suitable habitat exists mainly in a few side-valleys. Blue sheep were seen neither during transects of three long side-valleys in the Raskam drainage nor in three such valleys of the adjoining Urik drainage. However, tracks of several small herds indicated that the species existed in low numbers. Animals may

also be scarce to the southeast, an area we did not visit. For example, E. and N. Kowall (pers. comm.) crossed the Aghil pass and Oprang River and trekked extensively in the vicinity of K.2 during October-November 1985. Their camp cook once spotted a blue sheep herd in the distance, the only large mamm

als observed by the expedition in the reserve. Until surveys in the Taxkuzuke and Aghil ranges determine the status of blue sheep, a good estimate of numbers in the reserve is not possible except to note that there are probably a few thousand animals.

In May 1985, just before the birth season, adults tended to be sexually segregated; the composition of one herd was 49 males and 2 young. Herds were usually too far away for accurate aging and sexing of individuals. The horns of 72 males found in the field comprised 8% subadult animals (1-4 years), 55% in their prime (4-9 years) and 37% past prime (9-13 years). There were three times more past prime blue sheep than ibex (Fig. 5), a difference possibly reflecting greater hunting pressure on the latter.

Blue sheep and ibex share the same habitat in part of the reserve. On one occasion, the two species were observed near each other on the same slope, and on another occasion 25 ibex and 7 blue sheep foraged as one mixed herd. Both species are fairly common in the Mariang drainage. To the north, in the Datung drainage, ibex remain abundant whereas blue sheep are extremely rare; still farther north, only ibex are present. The demarcation between ibex and blue sheep distribution is at times abrupt. In the range bordering the upper Taxkorgan Valley, blue sheep occur on the eastern slopes of the watershed, and ibex on the western (Fig. 6). Similarly, ibex inhabit the

southern slopes of the eastern Karakoram and blue sheep the northern ones (Schaller, 1977).

With body size, habitat preference, and probably food selection similar in the two species, it remains unclear what, if any, ecological separation exists between them. The distributional overlap appears to be the result of both historical and ecological factors. Ibex have a wide distribution north, west, and south of Taxkorgan. Blue sheep are found primarily to the east, in the ranges on and bordering the Tibetan Plateau; they reach their western limit at the Shimshal Pass in Pakistan and in Taxkorgan. The two species may have colonised these Asian ranges from different directions until making contact. Two areas of overlap are so far known, one in Taxkorgan and the other in India south of Leh in Ladak (Schaller, 1977; Osborne *et al.*, 1983). The small amount of overlap is possibly related to availability of habitat: Mariang, where both species occur, is less rugged and has more pasture than Raskam, which supports only blue sheep.

Carnivores

Since only one snow leopard and two lone wolves were observed, carnivore data are based primarily on spoor.

Brown bear

Bear sign was found only in two valleys of the Mintaka block and in two valleys of the Raskarn drainage: the species is obviously rare in the reserve. Droppings contained grasses and sedges, marmot, and scavenged food, much of it Marco Polo sheep that had died of malnutrition (Table 3).

TABLE 3

Food Items in Carnivore Droppings from the Taxkorgan Reserve
(Expressed as percentage of total content in sample)

<i>Felis tigris</i>	<i>Snow leopard</i>	<i>Wolf</i>	<i>Brown bear</i>	<i>Red fox</i>
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	(Mariang and Raskam) n = 72	(Mintuka) n = 21	(Mintaka and Raskam) n = 9	(all areas) n = 92
Blue sheep	59-9	—	13-9	14-6
Ibex	4-2	14-3	—	3-3
Marco Polo sheep		9-5	25-6	3-3
Livestock	4-9	—	—	1-1
Marmot	29-1	75-7	5-6	13-2
Hare	1-0	—	—	4-3
Small rodent/ pi ka	~	—	—	53-7
Snowcock	0-2	0-5	-	1-2
Vegetation	0-7		54-9	5-3

prey density, and relative cat abundance, we estimate that perhaps 50-75 snow leopard frequent the reserve.

Of 72 late winter and spring droppings collected in the reserve, 64% of the content consisted of blue sheep and ibex, followed by marmot, livestock, and miscellaneous items such as hare *Lepus nigricollis*, snowcock *Tetragallus himalayensis* and grass (Table 3). Nine blue sheep kills were found, all males aged 4-10 years.

Livestock contributed little to the diet of the predators in our dropping sample, 5% in snow leopard, and 1% in red fox *Vulpes vulpes*, the latter probably scavenged (Table 3). However, our sample of droppings collected in spring and early summer does not reflect the total annual diet of predators accurately. Most livestock predation occurs in late winter, according to herdsman. Furthermore, people often discover and remove a carcass before the predator has eaten much, if at all, and the number of animals killed exceeds the number eaten. An insight into the amount of livestock predation can be gained from data collected by the Mariang commune, which, as noted earlier, has the densest snow leopard population in the region, as well as a few wolves. Between January 1984 and April 1985, commune members reported losses of 821 sheep and goats and 77 large animals, principally yak, or an approximate annual loss of 616 sheep and goats and 58 large animals. This represents an average loss of 3-3 sheep and goats and 0-3 large animals per family per year, or 7-6% of the sheep and goats and 1-7% of the large animals in the total livestock population. Interviews with herdsman verified these figures.

Wolves are the principal predator in the western part of the reserve. Nine families were queried about livestock deaths and five of them had lost animals to predators within the past year. In a total sample of 880 sheep and goats and 113 large animals, 23 sheep and goats (2-6%) and one yak (0-9%) had fallen prey, all but one sheep and the yak to wolves.

CONSERVATION

The Taxkorgan Reserve is a valuable addition to China's system of protected areas, and together with the contiguous Khunjerab National Park in Pakistan represents one of the most important wildlife areas in the mountains of Asia. However, the status of most large mammals in the reserve is precarious. Brown bear are threatened with extinction, only one small population of Marco Polo sheep survives, wolf and snow leopard are rare, and ibex and blue sheep are only locally common. Average density of

wild ungulates in the 1445 km² surveyed in the reserve was 0-34 animals km⁻². Although overgrazing by livestock and elimination of shrubs and trees for fuelwood by the reserve's many residents has greatly reduced

the carrying capacity of the land, the primary reason for the sparse wildlife populations is hunting. Ibex, blue sheep, and Marco Polo sheep have traditionally been an important supplementary food of the Tajik and Kirgiz. Military personnel, road maintenance workers and others kill animals for meat and trophies, especially in areas accessible by vehicle. Marmots—a main spring-to-autumn prey of wolf and snow leopard—are shot and poisoned because they compete with livestock for forage. With natural prey depleted, predators may kill livestock and they in turn are killed. Some are shot, either with private arms or rifles issued by the government for livestock protection; most, however, are caught in large steel traps which are used to capture everything from fox and snow leopard to bear and ibex.

Taxkorgan cannot become a viable reserve until the activities of the human residents with their livestock are modified; if present trends continue the reserve will become ever more arid and barren and ultimately contain almost no large mammals. The immediate concern of the government is, of course, to improve the living standard of these people, who subsist in an environment so severe that food subsidies are required. There is talk of increasing agricultural and livestock production. Even if possible it would ultimately just turn more land into desert. And since the human population is growing rapidly (the average household consists of 64 persons) even short-term benefits would be negligible.

Pragmatism demands that we limit suggestions for improving management of the reserve to what is currently feasible. Measures to curtail the unrestricted killing of wildlife are urgently needed. In 1987 two guards were posted in the Mintaka area to protect Marco Polo sheep, a useful first step. A ban on the use of steel traps and a recall of rifles provided to herdsmen for killing predators are being considered. The need for conservation education is locally recognised. A committee, composed of representatives from the commune, county, and forest department may be established to plan, execute, and enforce conservation measures. Most problems are difficult to resolve. For instance, the loss of three goats to snow leopards represents a considerable financial burden to a herdsman with just 50 animals, and the government lacks funds to compensate owners fully for each predator kill. However, losses could be reduced with better herding practices. Sheep and goats are often left unguarded, with herders and dogs either asleep or absent, and yak and horses may be left untended for weeks. But a change in herding would in turn require a break in traditional livestock grazing patterns, changing the division of labour among family members, as well as other adjustments. Although snow leopard have full legal protection, only understanding and willingness by both officials and herdsmen can reduce the death toll.

Conservation must take the aspirations of the local people into account, for the survival of wildlife and its habitat ultimately depends on them.

Immediate protective steps must be accompanied by measures which improve the living standard of the people without further disrupting the environment. This requires various new approaches. Appropriate technology needs to be introduced, such as solar stoves to reduce the demand for

fuelwood and greenhouses to raise produce. Apricots and other fruit could be grown commercially in some valleys. Any occupation that removes people from a dependence on land and livestock would benefit the reserve. The newly established international traffic between Pakistan and China through the area opens various possibilities, from trade and small business ventures to manufacture of distinctive handicrafts for sale to travellers. Tourism in the form of treks and yak or came) trips has potential. This would provide local men with employment as guides and camp staff and enable families to increase income by renting pack animals. Lee (1986) urged the killing of Marco Polo sheep by foreign hunters for a high fee. The animal is too rare in China to justify killing on any pretext, economic or otherwise, Furthermore, given complete protection. Marco Polo sheep could ultimately become a major tourist attraction.

At present China lacks a resident population of adult male Marco Polo sheep, animals apparently immigrating seasonally from Russia and Afghanistan. Just as Pakistan's Khunjerab National Park depended on an influx of sheep from China to maintain its population, so China appears to require animals from its neighbours. Perhaps the plight of this sheep in Pakistan and China can provide the impetus for the creation of one large reserve that encompasses the relevant border regions of Afghanistan, Russia, Pakistan and China.

Taxkorgan, like many of the world's reserves, can never return to pristine conditions; humankind with its agriculture and livestock is and will continue to be part of this environment. The future of the area as a viable reserve depends on the willingness of people to coexist with wild animals and to prevent further deterioration of habitats. Local support is essential in any conservation effort, but especially in a reserve like Taxkorgan where the needs of both people and wildlife must be met. Meaningful sacrifices and concessions by the people will depend on how well any management programme reflects local aspirations. To retain a reservoir of snow leopard and blue sheep and others presents a challenge as well as an opportunity to resolve a complex social issue which will ultimately affect almost all wild lands.

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