



RESEARCH, SURVEY AND BIODIVERSITY PLANNING ON THE QINGHAI-TIBET PLATEAU (DI 162/10/009)



Field Trip and Training Workshops July-September 2002

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Executive Summary

The field trip was carried out to collect the bulk of the biological and socio-economic data and carry out the assessments needed to complete Stage 1 of the project. Suojia district is situated in the Upper Yangtze Valley in the southwest of Qinghai Province. Ecologically, the Project Area forms part of the Tibetan Plateau and its fauna and flora are characteristic of that biome. The project area is also located in the San Jiang Yuan (Three Great Rivers Headwaters) Nature Reserve covering the upper reaches of the Yangtze, Yellow, and Mekong rivers. Project partners are the Qinghai Environmental Protection Bureau and the Upper Yangtze Organisation (UYO), a local NGO. UYO has helped to set up a Suojia Ecological Protection Committee, (EPC). Five local protected areas have been designated and EPC members monitor the wildlife in these areas.

The duration of the field trip was seven weeks. Subsequent work related to the project was carried out in Xining and Beijing. Most parts of the Project Area, and all five local protected areas, were visited during the course of the field work. Wildlife surveys and assessment of habitats, vegetation communities, and rangeland condition were also carried out in other areas. Socio-economic surveys were carried out in three parts of the Project Area. Training was organised in a range of subjects including biodiversity issues and conservation, practical management for people responsible for local PAs and rangeland management and effects of grazing for local herders. Formal meetings were held with UYO at the beginning and end of the field trip. Meetings were also held with Suojia leaders, EPB and others to report and discuss the results.

Good quantities of snow leopard sign and excellent populations of blue sheep, the major prey species, were found in the Snow Leopard PA. The Black-necked Crane PA contained 17 pairs of cranes and large numbers of other wetland species. A further 7 pairs of black-necked cranes were present in the Wetland PA. Several hundred kiang (Tibetan wild ass) were seen. Around 70 Tibetan antelopes were observed in the Tibetan antelope PA, which consists of an extensive area of ungrazed steppe. A small colony of white-lipped deer was found. No argali and only one wild yak were seen. Tibetan gazelle, Tibetan fox, red fox, wolf, lynx and several smaller mammal species were recorded. A list of breeding birds drawn up. The variety and abundance of mammal species present in the Project Area was markedly higher than in all the adjoining areas to the east.

The prevailing vegetation type is alpine (high-cold) meadow dominated by *Kobresia* spp., with extensive areas of high-cold steppe on drier, sandy soils. There are two large wetland areas as well as a number of small lakes in the project area. Extensive areas of Suojia's rangeland are in good condition with light or no grazing and high species diversity. The quality of some heavily grazed areas is deteriorating, but relatively few completely degraded areas were found. Less than 5% of the rangeland has been fenced. The human population in the Project Area has fallen over the past 17 years as a result of emigration. Social changes and changes in livestock grazing practices are complex and their effects vary. For example, a trend towards year-round grazing of the same area, induced by a move to winter houses rather than tents, has led to over-use of some pastures, but the effective abandonment of others. There is a marked contrast between the quality of the rangeland in the Project Area and in the areas to the east which are predominantly heavily grazed (short sward, prevalence of unpalatable species, high densities of livestock) and where extensive areas of pasture have been fenced.

Hunting has been banned in Suojia and all guns collected. Attitudes towards wildlife are generally positive and there is a sound basis for managing the rangelands in a sustainable way for the future benefit of local people and wildlife. Some issues of poverty and social welfare will also need to be addressed. Final status of the San Jiang Yuan NR will have a direct bearing on the future of the Project Area.

1. INTRODUCTION

1.1. The Suojia Project Area

The Project Area lies in Suojia District in the southwest of Qinghai Province and is situated in the Yangtze River headwaters region of the Qinghai-Tibet (Tibetan) Plateau (Figure 1). The Project Area covers an estimated 11,000 km². Suojia is bounded on the north and west by the upper course of the Yangtze, known as the Dri Chu in Tibetan and Ton Tien He in Chinese. The southern boundary more or less follows the watershed ridges between the Yangtze and Mekong. The Project Area consists largely of high-elevation plains, mountains and some wetlands. Apart from a narrow strip along the Yangtze River at 4350m, the whole Project Area lies above 4400m. Highest summits exceed 5700 but there are few peaks with glaciers and permanent snow. The main rivers are the Mug Chu, Ya Chu, Jiong Chu, and Dang Chu. Suojia district nominally extends across the Yangtze but the land on the northwest bank is not in *de facto* administrative control of the Suojia authorities.

Official figures show that average annual temperature is -4°C, average January temperature -14°C to -16°C and mean July temperature 8-10°C. Aggregate sunlight totals are 2600-2800 hours per annum and mean annual precipitation is 300-400mm (Anonymous 1990). Rain falls mainly in the summer and the resulting wet ground and high river levels hinder transport at this season. The Project Area is also subject to periodic winter snowstorms that vary in duration and intensity. An exceptionally severe storm that affected southwest Qinghai in October 1985 caused heavy mortality to wildlife and livestock in the Project Area, forcing many people to leave the area altogether.

According to official figures, there were 4377 people in 856 households in Suojia, though that figure had been reduced by emigration (Foggin 2000). The population has been declining since 1985, and is now believed to have stabilised. No official figure for the present human population of the district is available. Suojia township, situated on the east bank of the Mug Chu river, is the administrative centre of the district. There is a very small monastery at Churunge, an outpost of Gongsar Gompa, the religious centre of Zhiduo county, and tent schools at Yachu and Mugchu. There are no other population centres. Encampments reach elevations of 4800m.

The inhabitants are wholly dependent on livestock raising. Yaks, and to a lesser extent sheep, provide everything for subsistence including meat, milk, wool, hair for ropes and tents, and people depend exclusively on yak dung for fuel. No crops or winter fodder are grown in Suojia. Surplus animals and products such as sheep wool are bartered or sold for necessities such as barley, cooking oil and sugar. Families obtain a year's supply of these items at a time from traders from outside the area who make annual visits.

Little is known about the early history of the area. Suojia was formally established as a *xiang* (district) between 1966 and 1972. It is situated within Zhiduo County, and Yushu Prefecture. Suojia has four administrative sub-units (*mu-wei-hui*), named after the major rivers (Yachu, Mugchu, Jiongchu, and Dangchu). Each *mu-wei-hui* contains four 'work teams', making a total of 16 altogether.

Communications are poor. Horses and yaks have been traditionally used for transport and are still widely used, though increasing use is made of motor cycles and jeeps. A dirt road runs between Zhiduo and Suojia township. This is currently being upgraded but it retains a gravel surface and is still vulnerable to the effects of summer rainfall. A few other tracks have been established by custom but are completely unsurfaced. Off-road driving is a general feature where the terrain allows it. In winter when the Mug Chu river is low, the main road continues westwards, crosses the frozen Yangtze and links up with the main Golmud-Lhasa highway. Even here, not far from its source, the Yangtze is a major waterway that cannot be crossed outside the midwinter months and Suojia is thus cut off on two sides by the river for most of the year. Access into the district from the south is also difficult. This lack of through access has ensured Suojia's isolation and

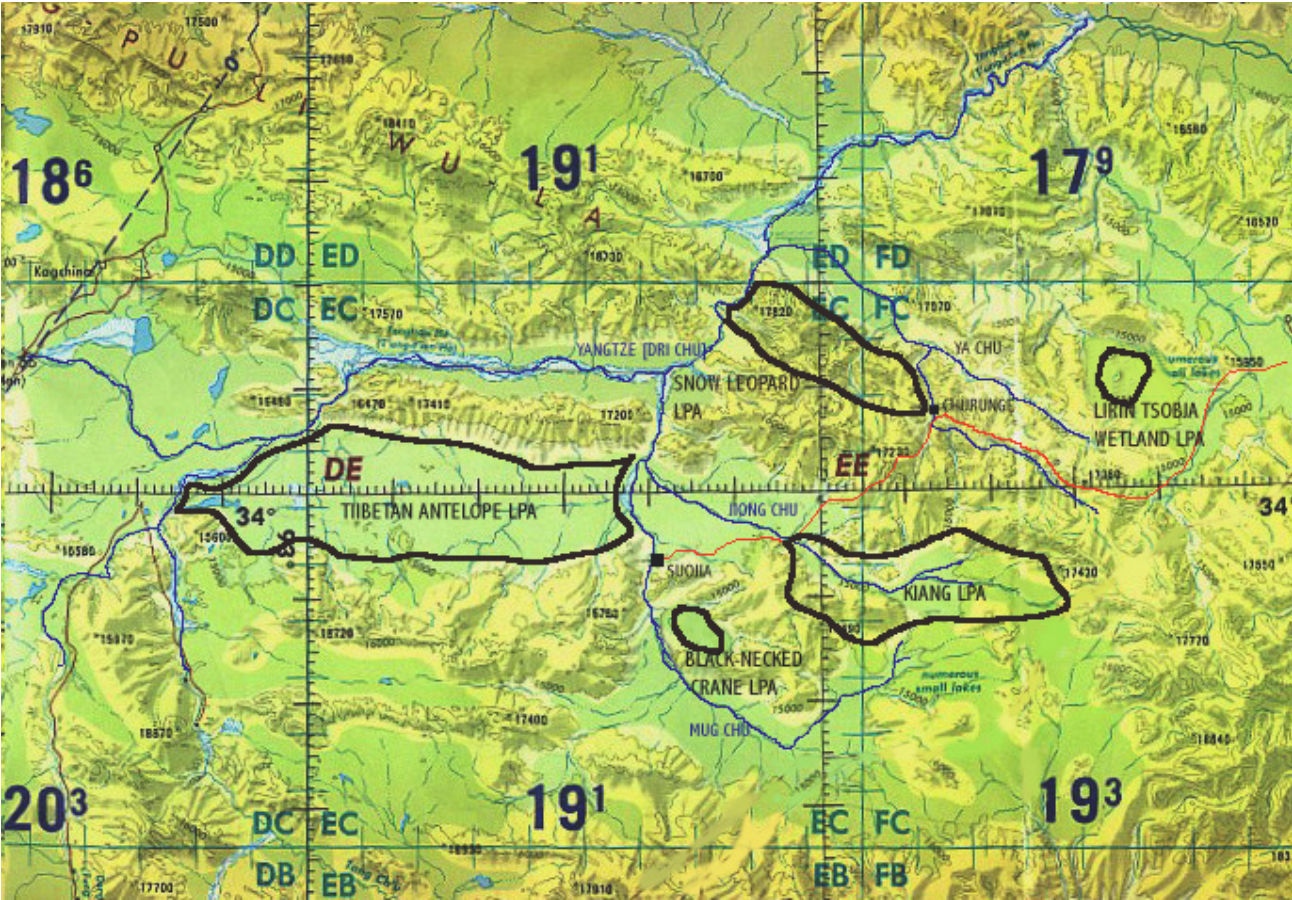
remoteness. Very few outsiders go there, even from the county or prefecture centres of Zhiduo and Yushu respectively.

Project partners are the Qinghai Environmental Protection Bureau and the Upper Yangtze Organisation (UYO), a local NGO with a remit covering biodiversity issues, training and sustainable rangeland use. UYO helped to set up, and works closely with, the Suojia Ecological Protection Committee (EPC) made up of township leaders and one member from each of Suojia's 16 work teams. The Suojia township authorities, in cooperation with UYO, have designated five local protected areas (LPA), one each for Tibetan antelope, snow leopard, wild ass, and black-necked crane, plus a wetland PA (Figure 2). EPC members monitor the wildlife in the LPAs and meet annually to pool the data. The district authorities have banned all hunting in Suojia and guns were confiscated by the government during 2001. The Project Area lies within the recently-designated San Jiang Yuan (Three Great Rivers Headwaters) Nature Reserve, an enormous protected area that covers the upper reaches of the Yangtze, Yellow, and Mekong rivers. A short preliminary field visit was made in November 2001 by a joint FFI, EPB and UYO team but adverse weather limited the time spent in the Project Area.

Figure 1: Location of Suojia



Figure 2: The Suojia Project Area



2. THE SUMMER FIELD TRIP

2.1 Participants

Dr David Mallon (FFI: biodiversity/rangeland surveys)

Dr Nasan Bayar (FFI: social and economic surveys)

Trashhi Bamba (FFI: interpreter/field assistant)

Du Jiang Tse (UYO/Suojia EPC)

Dola Abja (UYO: chief guide)

Gizong Abja (UYO: guide in Mugchu)

Nyima (UYO: driver)

Lo Du Chang (UYO: driver)

Other local guides assisted with some shorter components of the fieldwork programme. No-one from the Qinghai Environmental Protection Bureau, the project's government partner, was available to participate in the field visit.

2.2 Itinerary and Methods

The field survey team left Xining on 5 July and arrived back there on 21 August. Subsequent work on the project was undertaken in Xining and Beijing. Two four-wheel drive vehicles were used for travel into and around the Project Area and an independent fuel supply for these was transported to Suojia. A ten-day tour through the mountains of the Snow Leopard LPA was made on horseback and foot surveys were carried out where appropriate. Very wet roads, deep mud and high rivers hindered vehicle travel and prevented access to some parts of the Project Area altogether. However, all four *mu-wei-hui* and all five local protected areas were visited. No large-scale maps of the Project Area were available and the relevant Operational Navigational Charts at 1:1,000,000 and Tactical Pilotage Charts at 1:500,000 were used. Individual locations were recorded using a GPS.

The extent of each habitat in the Project Area was estimated and condition was assessed using qualitative and quantitative methods (production, cover and density). Principal vegetation communities in each habitat were identified and a photographic record made of each one and the important constituent components of the flora. Vegetation cover was assessed in 2x2m quadrats against standard cover cards. In each quadrat, the proportions of graminoids and herbs was estimated and the number of species of grasses, sedges and herbs recorded. Plants were identified to family, genus or species level wherever possible. The presence of unpalatable or toxic species present was also noted. Sod depth and sward height were measured and the degree of grazing estimated using standard indicators (e.g. sward height compared to ungrazed stands of the same vegetation community; proportion of intact shoots and leaves; presence or absence of litter or dead plant material from the previous year's growth).

Wildlife was observed using 10x binoculars and a 20-60x telescope. A baseline inventory of the mammals occurring in the Project Area that was drawn up on the November 2001 field trip, in collaboration with UYO, was refined and amended with the help of other local informants. Mammal records were obtained from direct observations, field signs and local reports. Additional information was subsequently obtained from mammal collections in the Institute of Zoology and distribution maps on the China Species Information Service database and the zoological literature. Birds were recorded by direct observation. Information on the fauna and flora of the Project Area was also obtained from printed sources with the help of a translator. Density estimates for large mammals were based on calculations made on transects, block counts and point scans as appropriate. Standard SLIMS transects were used to record snow leopard sign density. Human land use and grazing impacts were documented at individual sites. The invertebrate fauna of the Project Area was not investigated and no information was gathered on bryophytes, lichens or fungi.

An overall assessment was made of the condition of each Local Protected Area (LPA). The appropriateness of designated boundaries was considered and management needs discussed with local inhabitants and evaluated. Wildlife species present were recorded. The area of each LPA was estimated from polygons drawn on TPC 1:500,000 maps based on field survey data and information supplied by UYO and EPC.

At the end of the field visit, formal meetings to report the results and conclusions were held in Zhiduo with UYO and Suojia Township leaders, and in Xining with the Qinghai Environmental Protection Bureau. Other meetings relevant to the project were held in Xining with Qinghai Forestry Bureau, Northwest Plateau Institute of Biology, and ANZDEC Qinghai Forestry Management Project, and in Beijing with the Nature Reserve Division, Chinese Academy of Forestry and Institute of Zoology, Chinese Academy of Sciences.

3. RESULTS

3.1. Training and Capacity Building

Field and classroom training sessions had been organised on the November field trip for members of UYO. During the summer field visit, formal and informal training sessions on a range of topics were organised for the field survey team, members of UYO, Suojia EPC, and local herdsmen. More than 40 people received some basic training in general topics including: an introduction to biodiversity conservation, observational skills and note-taking, basic ecology of focal species, field identification of species occurring in the Project Area, use of telescope and Global Positioning System (GPS), and rangeland ecology. More in-depth sessions covered sign surveys and identification of tracks, basic survey and census techniques, habitat assessment and plant identification, and management of local protected areas. Workshops in the Snow Leopard LPA demonstrated snow leopard sign survey methodology, standard SLIMS transects and methods of distinguishing wolf and snow leopard kills. A formal classroom session was organised in the Black-Necked Crane LPA for five local herdsmen and members of the EPC with responsibility for monitoring the cranes, and two members of UYO. This covered the ecology of black-necked cranes, census and monitoring, use of telescope, and advice on management.

Members of the EPC and UYO take responsibility on the ground for conservation initiatives. Both organisations are capable, as their efforts in the Project Area so far and the organisation of the field trip logistics proved, but they are hampered in effectiveness by a lack of equipment – vehicles, communications, computers, binoculars and so on and funds for running costs such as fuel.

The issue of training was further addressed through interviews with members of UYO, EPC and local herders in all five Local Protected Areas to assess their requirements. There was a unanimous desire for further information, a basic guide to local wildlife and training in a range of subjects and at several levels. The principal requirements are:

- a basic guide to the main wildlife species of the Project Area written in Tibetan and Chinese with illustrations (this could serve as the basis for a manual for the whole Plateau)
- training for local herders on the basic grassland ecology and processes and sustainable rangeland use
- field identification, survey and census techniques
- monitoring techniques for members of Suojia EPC
- collation and storage of data using computer databases for Suojia EPC centrally
- practical management for people responsible for LPAs
- biodiversity conservation, rangeland management and computer skills for UYO

3.2. Habitats and Vegetation Communities

Chang (1981) identified five major regions on the Qinghai-Tibet Plateau and Schaller (1998) six. Both

authors agreed on the three broad divisions of the plateau rangelands: alpine meadow (in the east), alpine steppe (southern and eastern Chang Tang) and desert steppe (northwest Chang Tang). The Project Area is situated close to the boundary between the alpine meadow and alpine steppe. Chang and Gauch (1986) listed 26 vegetation communities in their study area in western Tibet and Achuff and Petocz (1988) identified five formations and 18 vegetation communities in Arjin Shan Nature Reserve on the northern edge of the Plateau. The *1:1,000,000 Vegetation Atlas of China* (Hou 2001) shows six communities in and around the Project Area. A preliminary list of 10 habitat types drawn up during the November 2001 field visit was revised and simplified. The main vegetation communities were identified where possible but detailed vegetation mapping was not undertaken; this would be an appropriate element of a later phase of the project. Considered at the landscape scale, the Project Area consists of a prevailing matrix of alpine meadow, with a central band of steppe, and containing smaller patches of wetland and mountains. The elevational range in Project Area is relatively narrow (generally 4400-5400m, with a few summits reaching 5700) and vertical zonation is limited.

3.2.1. Alpine (High-cold) Meadow

This covers about 75% of the Project Area and occurs in two broad types, on wetter and drier terrain. In both types, vegetation cover is high, often reaching 100%, and this habitat constitutes a very valuable grazing resource. Various species of *Kobresia* sedges, important fodder plants, are dominant or frequent. Twenty species of *Kobresia* have been recorded in Qinghai (Liu 1999). The most important species occurring in Suojia are *Kobresia tibetica* (including *K. schoenoides*, *K. littledalei*), *K. pygmaea*, *K. capillifolia* (including *K. capilliformis*, *K. bellardi*) and *K. humilis*. Species of *Oxytropis* and other legumes are frequent in all communities, ensuring adequate fixation of nitrogen.

A distinctive formation known as marsh-meadow occurs on wetter ground throughout the Project Area. This consists of hummocks of dominant *Kobresia tibetica* interspersed with small pools and hollows. It is characterised by a deep sod layer (30-60cm, occasionally up to 90cm) and sward height up to 45cm. Pools and hollows may make up 15-30% of the area. Vegetation cover on the remainder is usually 90-100%. These *Kobresia tibetica* meadows are highly productive, with average yields up to 2700kg/ha of dry matter (Ren 1986). *Kobresia tibetica* typically occupies 70-80% of the sward. Associated species include *K. humilis*, *Carex atrofusca*, *Carex* spp., grasses, *Aster* sp., *Leontopodium nanum*, *Saussurea tibetica*, *Saussurea* spp., *Gentiana aquatica*, *Parnassia nubicola* and several species of *Pedicularis*. *Ranunculus flammula* is frequent in the pools and hollows. Extensive tracts of marsh-meadow, up to 10-12km² in area occur in upper valleys. It is also found in shallow valley bottoms, on hill slopes with impeded drainage in mountains and on the summits of passes at elevations up to 4900m.

A drier type of alpine meadow occurs on better-drained slopes. It is characterised by a shallower sod layer of 5-12cm but the compact root systems contribute to formation of a tight springy turf that is resistant to trampling. Sward heights are typically between 5 and 20cm. The most prevalent vegetation communities are dominated by *Kobresia pygmaea*, *Kobresia pygmaea-Polygonum sphaerostachyum* and *Polygonum viviparum*. Common associated species of grasses and sedges include *Carex* spp., *Roegneria* spp., *Littledalea racemosa*, *Festuca ovina*, *Elymus nutans*, *Coeleria cristata*, and *Stipa* spp. Common herbs are *Leontopodium nanum*, *Oxytropis cansuensis*, *Oxytropis* spp., *Saussurea* spp., *Potentilla bifurca*, and *Arenaria* sp. At higher elevations herbaceous alpine become increasingly frequent, such as *Thalictrum alpinum*, *Anemone obtusiloba*, *Saxifraga engleriana*, *Pleurospermum* sp., *Primula megalocarpa*, *Cremanthodium* sp., *Lagotis kunawurensis*, *Corydalis* spp., *Soroseris pumila*, and *Androsace* sp.

A distinctive, herb-rich community is found on the northern slopes of Pomopondang (Seven Sisters) an 8km long limestone ridge on the south bank of the Jiong Chu river, with its crest at altitudes of 4600m. Vegetation cover is 80-100% with sward height averaging 25-35cm, and reaching 55-60cm in places. *Elymus nutans*,

Koeleria cristata, *Roegneria* sp., *Stipa* sp., and *Poa* spp. are the main grasses. Herbs consist of species of *Ranunculus*, *Inula*, *Silene*, *Gentiana*, with *Urtica hyperborea*, *Meconopsis horridula*, *Incarvillea younghusbandii* and two species of *Saxifraga* on rock ledges and steep gullies.

Much of the alpine meadow is in excellent or very good condition, while some sites are heavily grazed and rangeland quality is deteriorating. This is manifested by a lack of palatable species, frequent occurrence of the unpalatable *Oxytropis kansuensis*, reduced sward height, low percentage of palatable grasses and herbs, flattened tussocks, tussocks eaten down to the base, smaller tussock area and reduced tussock density. Areas showing signs of severe damage were restricted to patches around encampments. List some. Recommendations in grazing.

3.2.2. Alpine Steppe

A band of alpine steppe runs from west to east across the centre of the Project Area from the Yangtze to Jiongchu Bridge and is divided into two parts by the Mug Chu river. The western sector, between the Mug Chu and the Yangtze is known as Bazgonka and constitutes the Tibetan Antelope LPA. East of the Mug Chu is the Dilangaton plain, which grades into alpine meadow to the north, south and east. Steppe soils are drier than those in the alpine meadow zone, with little or no sod layer and a sand or sand-gravel substrate. Vegetation cover reaches a maximum of 30-40% and sward height is typically 5-12cm. *Stipa purpurea* is a frequent element of the flora and is dominant over large tracts especially on Dilangaton. Other common components include grasses such as *Poa* spp., *Roegneria* spp., sedges (*Kobresia robusta*, *K. humilis*, *Carex* spp.) and herbs *Leontopodium nanum*, *Oxytropis* sp., *Potentilla bifurca*, *Heteropappus* sp. and *Dracocephalum heterophyllum*. Species such as *Ajania tenuifolia*, *Meconopsis horridula*, *Artemisia* sp. *Dasiphora fruticosa*, *Rhodiola*, *Allium carolinianum*, *Pseudopleurum* sp., *Myricaria prostrata* and *Ceratoides compacta* are more local. Alpine steppe covers an estimated 1350km², about 12% of the Project Area.

Bazgonka has no regular grazing due to its status as the Tibetan Antelope Local Protected Area. Dilangaton is also rarely grazed, except at the margins near Suojia township, mainly because of a lack of available water; surface pools are mainly salty and drilling attempts failed to reach water. Both areas are in generally good condition. Steppe vegetation is widely regarded by local herdsman as providing inferior grazing.

3.2.3. Wetlands

There are two substantial areas of wetland in the Project Area, at Tsozhaton and Lirin Tsojba, both of which have been designated as local protected areas. Smaller patches of wetland habitat occur around pools and lake fringes and along some rivers. During the summer rains, temporary pools and waterlogged areas of steppe may occur all over the Project Area.

Tsozhaton wetland is situated on the east bank of the Mug Chu river, 6km south of Suojia township and covers an approximately 80km². Its extent is greatest during summer when rainfall soaks the perimeter grassland. The site consists of shallow lakes, marshes, channels and wet ground. Water from the lakes drains into an outlet stream along the northern edge that flows into the Mug Chu. A narrow strip of apparently similar marshes and pools lies along a small tributary on the west bank of the Mug Chu but was not investigated as it proved impossible to cross the river. Tsozhaton contains a mosaic of vegetation communities including those dominated by *Kobresia tibetica*, *Triglochin maritimum*, *Carex* spp., *Eleocharis* sp., *Juncus thomsonii*, and *Puccinellia* sp respectively. Strips of emergent *Hippurus vulgaris* occur along some lake edges. Other component species of these communities include *Triglochin palustre*. Sand dunes and slacks occupy the northwest corner, with a striking, herb-rich flora containing three species of *Pedicularis* and a number of other species.

Lirin Tsojba wetland lies in the northeast of the Project Area in the upper course of the Bam Chu river. It

covers about 75km² of undulating *Kobresia tibetica* marsh-meadow interspersed with around 150 pools and lakes. There is little emergent or marginal vegetation apart from small stands of *Hippurus vulgaris*. The flora is markedly less diverse than at Tsozhaton.

Three small permanent lakes and pools in the steppe north of Suojia town consist of a small complex of shallow spring-fed pools and marshy areas. These contained either salt tolerant/haplophytic communities mainly dominated by *Triglochin maritima*, or *Puccinellia* sp., and with patches of *Kobresia tibetica* vegetation. A fourth lake was surrounded by a band of damp meadow dominated by *Kobresia* and *Carex* species, with other herbs such as *Thermopsis lanceolata* and *Saussurea* sp. Another small lake is situated just inside the district boundary on the eastern edge at an elevation of 4813m. The largest single body of water in the Project Area is a salt lake situated at the eastern end close to the Yangtze River. It could not be reached during the field visit. Some other small lakes were reported to lie in the upper Mug Chu valley.

Wetlands of all kinds including open water cover an estimated 3-4% of the Project Area. The condition of these habitats varies. Tsozhaton is in general in excellent condition. This is largely due to the attitude of the local inhabitants who accept its status as the Black-necked Crane LPA and recognise the need for light or seasonal grazing. Lirin Tsozha has a much higher density of livestock and the effects of heavier grazing pressure on the vegetation are clearly visible in lower overall sward height, reduced tussock density, absence of palatable grasses and herbs and low proportion of new shoots. Some local herdsmen in the area voiced concern over the declining quality of their pastures, but blamed it on lack of rain rather than high numbers of sheep and yaks. The smaller wetlands were mainly in good condition, their location in the steppe zone protecting them from regular grazing.

3.2.4. Scrub

There is very little scrub in the Project Area. Small patches dominated by a sparse cover of *Dasiphora fruticosa* bushes occur in some stony valley beds in the mountains. Bushes may reach 60cm in height where ungrazed. A tamarisk *Myricaria prostrata* occurs occasionally, particularly in stony river beds. A dwarf willow *Salix* sp. and a species of *Lonicera* were encountered on higher slopes in some upper valleys of Tramkar Rasan but the areas dominated by *Salix* did not exceed a few hundred square metres. A 300m long slope below cliffs on the south bank of the Yangtze was covered with a mixed scrub and tall herb vegetation community unique in the Project Area, consisting of *Clematis tangutica*, *Artemisia* sp., *Lonicera* sp., *Berberis* sp. No evidence was found that the existing scrub is exploited for fuel. Fragments of scrub vegetation together amount to less than 1% of the Project Area. There are no trees in the Project Area.

3.2.5. Montane

This habitat occurs above the alpine meadow, beginning at varying elevations from about 4750-4900m depending on aspect, slope and other factors. There is no sod layer, this being replaced by a stony or gravel substrate. Vegetation cover is low, 10-30%, though occasionally reaching 50% at snow patches. Sward height is also reduced to 3-8cm and cushion plants increase in frequency. Plant communities generally share many species with alpine meadow communities. Common components are *Leontopodium nanum*, *Saussurea medusa*, *Saussurea* spp., *Oxytropis* sp., *Astragalus* sp., *Meconopsis horridula*, *Arenaria*, *Rhodiola*, and more typical alpinines such as *Thylacospermum caespitosum* and *Draba oreades*. This habitat covers an estimated maximum of 5% of the Project Area. Livestock only occasionally reach these elevations and there were no visible effects of grazing.

3.2.6. Glacier and Rock

These are devoid of any vegetation cover and occupy only a small area, also estimated at a maximum of 2-3%.

3.2.7. Black Soil/Black Sand Pastures

These terms are used by Chinese scientists to refer to areas of eroded grassland. Their origin has been attributed to a number of different factors, including freeze-thaw erosion, overgrazing and trampling by livestock, turf cutting, and high densities of pikas, mole rats or other small mammals. These factors may overlap or interact, making determination of the primary cause more difficult.

Within the Project Area cracks or wider parallel splits run across many hill slopes. Most or all of these appear to be natural in origin, result from freeze-thaw processes. Patches of bare soil are exposed along the line of these cracks where the turf has been forced up and these may be exploited, and possibly enlarged, by livestock grazing or used by pikas as burrow sites. However, many of these bare patches, even those close to encampments, are partially or completely revegetated, often with a dense cover of *Leontopodium* and various grasses.

High densities of pikas have often been blamed for the formation of black sand areas on the Qinghai-Tibet Plateau, prompting mass poisoning campaigns aimed at their eradication. However this is a controversial theory, with several reports indicating that pikas occur at high density only where the ground has already been degraded by overgrazing or other factors. Highest pika density the Project Area occurred on severely-worn ground in the vicinity of three encampments. There was no evidence to support the idea that pika activity directly damaged the rangeland, and nor did local herders express any concern to that effect.

Between a third and a half of the habitats in the Project Area show some signs of erosion but the majority of this is due to natural processes. Bare or worn ground surrounded most camps and a few localised patches of damaged pasture were seen where vegetation cover had been severely degraded or totally removed. Areas damaged by overgrazing are estimated to cover no more than 10%, though this figure does not include rangeland subject to heavy grazing that may be deteriorating. No extensive areas were found that could be unequivocally identified as 'black soil'.

3.3. Wildlife

3.3.1. Mammals

Twenty-three mammal species have been recorded in the Project Area, based on evidence from sightings, field signs and local reports. These are listed in Table 1 along with their local and Chinese names. Some unidentified small mammals were also observed. Musk deer have reportedly disappeared from the Project Area, wild yak no longer occur there on a regular basis and the current status of Tibetan argali is unknown. Eight species and one subspecies out of the 23 are endemic to the Qinghai-Tibet Plateau. This mammal assemblage contains all the species expected to occur in the area.

Table 1. Mammal species recorded in the Project Area

Species	Scientific Name	Local name ¹	Chinese name ²
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Snow Leopard	<i>Uncia uncia</i>	sah	xue-bao
Lynx	<i>Lynx lynx</i>	eega	she-li
Pallas' Cat	<i>Otocolobus manul</i>	tuli	chu-mao
Wolf	<i>Canis lupus</i>	hionk	lang
Red Fox	<i>Vulpes vulpes</i>	wa	huli
Tibetan Fox*	<i>Vulpes ferrilata</i>	bay	sha-hu
Brown Bear	<i>Ursus arctos</i>	dremong	xiong
Otter	<i>Lutra lutra</i>	sam	shwei-ta
Steppe Polecat	<i>Mustela eversmanni</i>	tilu	ti-lu
Himalayan Weasel	<i>Mustela sibirica</i>	saymon	hwang-shu-lang
Kiang*	<i>Equus kiang</i>	jiong	yeh-lu
Wild Yak*	<i>Bos grunniens</i>	drong	yeh-mao-niu
Tibetan Antelope*	<i>Pantholops hodgsoni</i>	tsö	tsang-ling-yang
Tibetan Gazelle*	<i>Procapra picticaudata</i>	goa	hwang-yang
White-lipped Deer*	<i>Cervus albirostris</i>	sha-oo	bei-tun-lu
Musk Deer	<i>Moschus chrysogaster</i>	sashi	xeh-sheh
Blue Sheep	<i>Pseudois nayaur</i>	na	shi-yang
Tibetan Argali*	<i>Ovis ammon hodgsoni</i>	hnyeh	pan-yang
Woolly Hare*	<i>Lepus oiostolus</i>	ribong	tudz
Black-lipped Pika*	<i>Ochotona curzoniae</i>	abra	shu-tu
Large-eared Pika	<i>Ochotona macrotis</i>	zabra	shu-tu
Himalayan Marmot	<i>Marmota himalayana</i>	shio	ham-ta
Tibetan Hamster*	<i>Cricetulus kamensis</i>	tsögö	shu

¹ phonetic transcription of the local Kham Tibetan dialect
² local pronunciation in the Project Area
* endemic to Qinghai-Tibet Plateau

KIANG OR TIBETAN WILD ASS (*Equus kiang*)

Kiang were seen in all parts of the Project Area except the Tramkar Rasan mountains and Yachu in the northeast. They are the most numerous ungulate species in the Project Area. Numbers were highest in Jiongchu (Kiang LPA) and adjacent plains. Smaller numbers were observed around the edges of the Tsozhaton wetland, on Dilangaton and Bazgonka steppes, and Ronjuk plains along the south bank of the Yangtze. In total 1631 kiang were counted. Herd size ranged from 1 to 162. The very clumped distribution pattern made it difficult to calculate a reliable density figure using standard line transect techniques. More reliable results were obtained from point scans from high ground using a telescope. Maximum density observed was 15.2/km² in a 25km² survey block. Averaging out the figures for all survey blocks suggests a population of around 6000 in the Jiong Chu area with a few hundred elsewhere in the Project Area. The total population in the Project Area is estimated at a maximum of 7500, a figure supported by local estimates of abundance based on winter counts. Kiang numbers were widely reported to be increasing since the ban on hunting was introduced and many herders felt there was increasing competition for grazing with their livestock.

Young kiang were first observed on 22 July when five females each accompanied by a very small young animal were observed at a calving ground in Jiongchu. Local people said these had been born two days previously. As only a few young were present, the main birthing period must take place somewhat later. Kiang are the least wary of the ungulates occurring in the Project Area and could be approached on foot to a distance of 50m before moving away, except for females with young who were much more wary. Remains of

a kiang killed and partly eaten by three wolves were found during the November field trip. Kiang were subject to some subsistence hunting by local people for meat and skins until recently. They are not currently globally listed as threatened (IUCN 2002).

WHITE-LIPPED DEER (*Cervus albirostris*)

One group of 25 animals was found on 10 July on Churazaleye Mountain, on the southern side of the Ya Chu river and a day was spent observing the animals and assessing their habitat. The group consisted of adult females, yearlings and four young. No adult males were seen. Tracks, droppings and sleeping places were noted on the summit plateau at 5030m. The animals were first seen resting on a barren stony slope at an elevation of 4950m. At around 13h30 hours they began to graze and moved slowly down through an area of rich *Kobresia pygmaea*-*Polygonum sphaerostachyum* meadow. They paused for some time in a patch of *Kobresia tibetica* marsh and they drank from a small stream. After another rest period of 2 hours they again began grazing and moved slowly back uphill out of sight by 18h15 onto the southwest side of the mountain. According to local herders this herd occupied a very small range, never moving off the mountain. This is the only confirmed population of white-lipped deer remaining in the Project Area so its continued survival is important.

White-lipped deer formerly occurred elsewhere in the Project Area according to local reports. No signs of current presence were found in one former locality in Tramkar Rasan. They were also reported to occur on the eastern border of Suojia district, south of the main road in from Zhiduo, but this site could not be reached during the field trip. Total numbers must have been higher in the fairly recent past: one informant described leaving the mountains with a yak-load of antlers in his youth. Around 260 white-lipped deer are kept in a large fenced enclosure at the county centre of Zhiduo and farmed for their antler velvet, sold for its medicinal properties. White-lipped deer are classified as Vulnerable in the 2002 IUCN Red List of Threatened Species (IUCN 2002).

- There are no direct threats to the Churazaleye population at present, but they share the area with yaks and sheep from nearby encampments and the possibility of placing some restrictions on numbers of livestock should be investigated to reduce disturbance and competition for grazing.

MUSK DEER (*Moschus chrysogaster*)

A large old latrine site containing several hundred droppings was found below an overhanging cliff on the south bank of the Yangtze. According to local informants, musk deer were formerly distributed sparsely in the Project Area but no longer occur there. All species of musk deer have long been an object of hunting for their musk across their entire range.

WILD YAK (*Bos grunniens*)

A single animal was observed on the banks of the Yangtze from Ronjuk plain on the edge of the Snow Leopard LPA. Wild yak bones were found in the lower Mug Chu valley and other remains at two places in the Snow Leopard PA. These consisted of a horn fragment in Méné Rong and a frontlet and horn cores retrieved from the Bémé Chu river. They were easily distinguished from those of domestic yak by their massive size. Wild yaks formerly occurred widely in the Project Area but have disappeared in recent years as a resident species and now occur only very occasionally in the north. A single animal was seen by local inhabitants in Yachu in 1999. Local people traditionally utilise wild yak horns as storage vessels for milk, but these have become rare and valuable objects. Wild yaks have always been prized for their meat and their range across the Plateau has contracted because of hunting (Schaller 1998). Hunting brigades organised following the establishment of Suojia township in order to feed the newly-arrived people no doubt contributed to the decline of this species in the project Area. A Wild Yak LPA designated by UYO is situated on the northern bank of the Yangtze, adjacent to the Project Area. Although nominally a part of Suojia district, it is effectively the responsibility of people from Chumalai county who now graze this area. Eventual

recolonisation of the Project Area from surviving wild yak populations to the northwest is in theory a possibility. Wild yak is listed as Vulnerable in the 2002 IUCN Red List of Threatened Species (IUCN 2002).

TIBETAN ANTELOPE OR CHIRU (*Pantholops hodgsoni*)

Tibetan antelope occur on the Bazgonka plain, between the Mug Chu and the Yangtze, an area that forms the Tibetan Antelope LPA (approximately 1000km²). They were observed during the field visit in the eastern part of this area when 65 animals were counted in a 150km² survey block, by means of systematic vehicle transects and point scans using binoculars and telescope. This represents a minimum density of 0.43/ km² (as some animals may have been missed) and would suggest a summer population of c.430 in the whole LPA. It is likely that this figure is an underestimate, as local herders reported higher numbers present around a salt lake at the western end of Bazgonka, a locality that could not be visited as the road heading to it was impassable. All the animals seen were males. Females are normally present in the Project Area only in winter and they migrate back north to calving grounds in Kekexili before the winter ice melts on the Yangtze. However, disturbance in 2002 caused by construction of the Golmud-Lhasa railway line is known to have disrupted their normal movements to some extent and some females may have remained in the Project Area. One group of tracks found clearly showed a much smaller set of prints with a group of adult-sized ones, indicating the possibility that young had been born there this year. The 65 animals observed were in groups of 1-27. They were mostly seen in damp grassy flats along the Baz Chu River, but also occurred in areas of sandy steppe and numerous sets of tracks were found there too. With one exception all animals were extremely wary and fled as soon as they detected the approach of the vehicle. This behaviour reflects the illegal hunting which takes place in winter though local people do their best to monitor and deter it. Tibetan antelope formerly occurred right across the steppe zone in the Project Area, from the Yangtze to Jiongchu Bridge. Local reports suggest they were numerous, with one informant describing the plain “white with antelopes” when he first arrived after ‘Liberation.’ Tibetan antelope disappeared from the Dilangaton steppe, east of the Mug Chu river, following the October 1985 snowstorm. The disastrous effect of this event on the Tibetan antelope population of Qinghai was documented by Schaller & Ren (1988). The Project Area population was no doubt further reduced by hunting for meat and later for its valuable underfur (*shahtoosh*). An upsurge in commercial poaching for this trade in recent years has resulted in the slaughter of populations across the whole Qinghai-Tibet Plateau depleting numbers and reducing their range, especially in eastern Qinghai and central Tibet (Schaller 1998; IFAW/WTI 2001). Tibetan antelope is classified as Endangered in the 2002 IUCN Red List of Threatened Species (IUCN 2002) and identified as a high priority species for conservation action by IUCN’s Antelope Specialist Group (Mallon & Kingswood 2001). Steppe habitats in the Project Area are in good condition, providing the potential for future population expansion, assuming effective protection from illegal hunting is provided. Recommendations for conservation are included below in the section covering the Tibetan Antelope LPA.

TIBETAN GAZELLE OR GOA (*Procapra picticaudata*)

This is a widespread species in small numbers across the Project Area. Tibetan gazelles were observed on Bazgonka and Dilangaton steppes, along the Mug Chu valley below Suojia township, at Tsozhaton wetland, the foothills of Tramkar Rasan and hill summits above 5000m. Most were seen in steppe habitats but animals were also seen in wetland margins and richer sedge meadows of Tsozhaton and the eastern end of Bazgonka, alpine meadow, stony montane plateaux, and plains along the Yangtze.

In total, 151 were seen. Adult sex ratio was 79 males:100 females. Group size ranged from 1-10 with a mean of 2.24. Thirty-three sightings were of single animals. One group of 10 and two groups of seven animals were observed. Mean densities in three survey blocks were 0.2, 0.22 and 0.3 per km². However, these figures represent the most favourable habitats and are not applicable to the Project Area in its entirety. In many areas, no Tibetan gazelles were seen. Taking this into account, the total population in the Project Area is unlikely to exceed 1000. Males and females were generally segregated, but one mixed herd was seen. The first young were observed on 30 July. According to Schaller (1998) young Tibetan gazelles remain hidden for up to two weeks before accompanying their mother, which would suggest that births in Suojia take place around the middle of July. The species is still widely distributed across the Qinghai-Tibet Plateau and its total population

may reach 100,000 (Schaller 1998). Tibetan gazelle is listed as Lower Risk in the 2002 *IUCN Red List of Threatened Species* (IUCN 2002).

BLUE SHEEP (*Pseudois nayaur*)

Widespread and numerous in Tramkar Rasan and mountains east of the Ya Chu River and seen in smaller numbers on Dorje Ondra mountain, south of Suojia township, and on other hills in the Project Area. Blue sheep were also reported to occur in upper Jiongchu, Lanalung and in the hills north and south of the Tibetan Antelope PA; they probably occur on small massifs and rocky hills throughout the Project Area.

In total 1538 blue sheep were seen. Blue sheep group size had a very wide range, 1-140, with a mean of 23. Based on block counts and censuses along travel routes, density in Tramkar Rasan is estimated at a minimum of 5.6/km², a figure which compares well with their range elsewhere in the Himalaya and Tibet (Mallon 1998). Adult male to female ratio was 72:100. However, adult male blue sheep are known to segregate and occupy higher elevations than female and young animals so they may have been under-represented in the sample of animals observed. Several local people reported that an unknown disease had affected the blue sheep population during winter 2001-2002, resulting in heavy mortality of males, though several herds containing mature males of Class III/IV were seen. Young to adult female ratio was 73:100. Blue sheep were formerly hunted for meat on a local subsistence basis by some families but all hunting is now banned. Several groups of blue sheep were seen foraging close to houses and camps and the animals were clearly not hunted. Blue sheep are listed as Near Threatened in the 2002 *IUCN Red List of Threatened Species* (IUCN 2002) but are currently under consideration by the Caprinae Specialist Group for possible downlisting to the Least Concern category.

TIBETAN ARGALI (*Ovis ammon hodgsoni*)

The only record obtained during the field visit was of an old set of horns found at an abandoned encampment in the southeast of the Project Area. According to local reports, Tibetan argali used to occur sparsely in the mountains around the headwaters of the Jiong Chu River, the south of Dang Chu, and in the Tramkar Rasan Mountains in the north but have not been seen at these sites since the 1985 snowstorm. Some of these former localities were not investigated during the field visit because they were too remote, or because high river levels prevented access to them. It was therefore not established whether or not Tibetan argali are still present in the Project Area. This is the rarest wild ungulate species on the Qinghai-Tibet plateau occurring sparsely everywhere (Schaller 1998). Only two argalis were seen during months of fieldwork in Qinghai and Gansu (Schaller et al. 1988). This subspecies of argali is listed as Vulnerable in the 2002 *IUCN Red List of Threatened Species* (IUCN 2002). Recommendation:

- Re-survey all sites where presence was known in the recent past to assess current status

SNOW LEOPARD (*Uncia uncia*)

One snow leopard was seen and part of a snow leopard skeleton, consisting of spine and tail, was found in the Snow Leopard LPA in Tramkar Rasan. Snow leopard sign (tracks, droppings and scrapes) was widespread there and in the adjacent mountains. One freshly-killed blue sheep with the characteristic killing bite of the snow leopard - two holes made by the canines on the back of the neck - was found high in a rocky gully and remains of seven more blue sheep were also found. Eleven formal transects were walked following the standard snow leopard survey protocol. These varied in length from 300m to 1000m and were sited along likely snow leopard travel routes - gorge beds, cliff bases and ridge lines. Sign density on transects ranged from 2-36 per km. The three transects with the densest sign were located in the Drolhochen sub-catchment which has been zoned as a sanctuary area for snow leopards and their prey and left ungrazed by domestic livestock for the last three years. It is also subject to very little disturbance. These three areas had high level of ungulate presence, high ruggedness and no grazing. The most frequent topographic feature associated with snow leopard sign was a cliff base or rock overhang along a valley bottom with smaller numbers placed on ridgelines. Ridgeline placement coincided with dips in the ridge, effectively forming a route junction. In a small number of valleys, fresh tracks were found, including those of an adult with young, but scrapes were extremely sparse, a finding that conforms with the observations reported by Schaller et al. (1988) for other

ranges in Qinghai. The three other participants of the Snow Leopard LPA survey team were trained in snow leopard sign survey techniques and their participation contributed to the efficiency of the surveys.

Snow leopard predation on livestock was low in comparison with wolves and every herder interviewed regarded the snow leopard as less of a threat than the wolf. In Yachu, only a few sheep were reported to have been victims of attacks in the winter 2001-2002. A snow leopard killed two sheep near an encampment downstream from Churunge Gompa in spring 2002. Herders generally seemed to accept some level of predation as a fact of life. All livestock kills by snow leopards reported in the Project Area involved stray animals on hillsides. There were no instances of multiple killing in night corrals or animal pens, a regular occurrence in some parts of the snow leopard range (e.g. Mallon 1991) and one which causes much greater economic hardship. Nonetheless, snow leopards were certainly killed as actual or potential predators on livestock until hunting was banned. In Yachu it was reported that over 40 snow leopards had been shot or trapped between 1972 and 1997. None had been killed since the hunting ban was imposed by the local government. In Tramkar Rasan, 11 snow leopards were reported to have been shot in the vicinity of Bémé Rong over an unspecified time period and one snow leopard that had killed and carried off a sheep in Méné Rong was followed by the owner to a small cave where he shot it. A small memorial stone inscribed and left by the herder is still visible. The snow leopard is globally listed as Endangered in the *2002 IUCN Red List of Threatened Species* (IUCN 2002). Snow leopards occur on all major mountain ranges and some small massifs in Qinghai (Schaller et al. 1988). These authors estimated a total of 650 snow leopards in Qinghai, at a mean density of 1:100km². Density in the Project Area is estimated to exceed this. No snow leopard skins were seen for sale at fur shops in Xining or other prominent markets. Recommendations (additional to those made in the Snow Leopard LPA section):

- Collate local reports of snow leopard presence in the Project Area outside Tramkar Rasan
- Survey these areas and map using GPS
- Collect records of snow leopard predation on livestock, analyse patterns, identify 'hotspots' take remedial action where necessary
- Assist UYO to organise surveys on the north side of the Yangtze to assess contiguous populations

LYNX (*Lynx lynx*)

Lynx tracks were found on two occasions along the foot of the Seven Sisters (Pomopondang) ridge. The second set had been made during the five days between the two visits. Some of the tracks were found in a cave that also contained droppings and apparent prey remains - a marmot skull and Tibetan gazelle bones. Two local people reported a sighting of a lynx in mid-July at the eastern end of Dilangaton plain, about four kilometres from where the tracks were found. All local people interviewed were familiar with the lynx and could recognise it from photographs. On the basis of these local reports, it is distributed widely but sparsely in the Project Area.

MANUL or PALLAS'S CAT (*Otocolobus manul*)

A breeding den was seen at Rayalaha in the southeast of the Snow Leopard LPA. The den was situated at 4740m in alpine meadow habitat on a shallow south-facing slope a short way above a summer encampment. The herders reported that two cats were present when they arrived from their winter quarters in early July, and that the pair had been seen with three young on several occasions. They had last been observed about two weeks previously (i.e. mid-August). The den had two entrances about 20cm high with a patch of well-trodden earth outside. There was no sign of current presence. Two manuls were observed during the November 2001 field trip near Chumalai, about 80km from the Project Area. This species is listed as Lower Risk in the *2002 IUCN Red List of Threatened Species* (IUCN 2002).

WOLF (*Canis lupus*)

Three wolves were watched at length on two consecutive days in Tsozhaton Black-Necked Crane LPA. Another was seen in Drolhochen Valley in the Snow Leopard LPA. Wolves killed a sheep at our camp at

Rayalaha in Tramkar Rasan during the night of 7-8 August, and they were heard howling at the same location the following night. Tracks and droppings were found at 18 further localities. On the basis of local reports wolf distribution covers the whole of the Project Area. Every herder interviewed reported that wolves were the main wild predator on domestic livestock, mainly sheep, and were a much greater threat in this regard than snow leopards.

TIBETAN FOX (*Vulpes ferrilata*)

There were 12 sightings of this species, on Dilangaton steppe, Jiongchu, in and around Tsozhaton wetlands, and in the Snow Leopard LPA. It was seen in alpine steppe, sand dunes, wetland edge reeds and alpine meadow. They were active during the day. One was seen to catch and eat a black-lipped pika (*Ochotona curzoniae*). On the basis of sightings and local reports, the Tibetan fox is fairly common and distributed across the Project Area. It is endemic to the Qinghai-Tibet Plateau. Two additional animals sighted were probably this species but were too far away to be separated with certainty from red fox.

RED FOX (*Vulpes vulpes*)

Four individuals were observed. Three of these were in approximately the same locality at the eastern end of Dilangaton plain and the other was in the upper part of the Bémé Valley in the Snow Leopard PA. Red foxes are distributed across the Qinghai-Tibet Plateau (Zhang 1997; Schaller 1998) and are hunted throughout the Tibetan region for their fur, greatly valued for making winter hats.

OTTER (*Lutra lutra*)

The only record obtained was a fresh spraint on a rock ledge above the Yangtze River on the northern edge of the Project Area. Local informants also reported a limited distribution along the Yangtze and the on lower course of the Ya Chu river. No field signs were found during surveys along the Mugchu River above and below Suojia town, or on the Ya Chu in the vicinity of Churunge Gompa. Otter fur is used in eastern and northeastern Tibet to trim traditional costumes.

STONE MARTEN (*Martes foina*)

Marten tracks were found in three localities in the Tramkar Rasan mountains. Many local informants reported it present in the Project Area. The stone marten is distributed widely across the Qinghai-Tibet Plateau (Zhang 1997; Schaller 1998; Sheng et al. 1999).

STEPPE POLECAT (*Mustela eversmanni*)

This species was known to local people and readily identified from photographs, but no direct records were obtained during field work. It occurs widely across the Qinghai-Tibet Plateau (Zhang 1997; Schaller 1998; Sheng et al. 1999).

HIMALAYAN WEASEL (*Mustela altaica*)

An intact skull was retrieved from a pellet found below a cliff used by saker falcons and upland buzzards. No weasels were seen, which is rather surprising in view of the abundance of pikas in the Project Area. One was seen on the November field trip close to the road pass over the Bayan Kara mountains at an altitude of 4686m. It occurs widely across the Qinghai-Tibet Plateau (Zhang 1997; Schaller 1998; Sheng et al. 1999).

BADGER (*Meles meles*)

Some local informants reported badger occurrence in the Project Area, and they correctly identified it from photographs, but no field signs were found. A badger skin used as a saddle decoration was seen in Tsozhaton, but the owner did not know its place of origin. No localities are mapped for badger in this part of Qinghai by Zhang (1997).

BROWN BEAR (*Ursus arctos*)

One bear approached the base camp tents at Yehlholung (4788m) in the Snow Leopard LPA, but was scared

off by the encampment dogs. Bear signs (tracks, droppings, excavated marmot holes and a summer den) were found at seven sites in the Snow Leopard LPA in Tramkar Rasan mountains, at elevations between 4580 and 4820m. Local inhabitants reported bear presence in all mountain areas in Mugchu, Yachu and upper Jiongchu. In Yachu there were two reported incidents of bears forcing their way into houses during spring 2002. The houses were unoccupied at the time. The bears consumed stored food, and caused a lot of damage. Many other local informants reported sporadic raids by bears on houses or tents in recent years and very occasional attacks on people. No bear skins were seen.

WOOLLY HARE (*Lepus oiostolus*)

Only four hares were sighted: one on the Pomopondang ridge; two in alpine meadow south of Suojia town and one in sandy steppe to the north of town. Very few hare droppings or other field signs were found and this species seems genuinely scarce in the Project Area, in contrast to its status in the drier western and northwestern parts of the plateau (Mallon 1991; Schaller, 1998).

BLACK-LIPPED OR PLATEAU PIKA (*Ochotona curzoniae*)

Abundant and widespread throughout the Project Area. They were frequently seen around herders' camps, occasionally entering tents and even sheltering within them. Highest densities occurred on partially-bare and trampled terrain around encampments. An albino individual that had been caught by a herdsman in Jiongchu was seen and photographed. Black-lipped pikas are preyed on by several terrestrial and aerial predators and it is a key element in the regional food chain. Black-lipped pika remains occurred in 76 out of 100 randomly selected raptor pellets found below cliffs used by upland buzzards (*Buteo hemilasius*) and saker falcon (*Falco cherrug*). Several bird species, notably red-necked and white-rumped snowfinches, use pika burrows as nest sites and its role as a keystone species on the Tibetan Plateau was discussed by Smith & Foggin (1999; 2001). Pikas are also widely regarded as pests and blamed for damaging or destroying rangeland. Mass poisoning campaigns have been conducted with the aim of extirpating pikas from large areas with consequent adverse effects on local food chains. Some poisoning of pikas was carried out in Suojia during the 1970s but not since then and the Project Area is currently unaffected.

LARGE-EARED PIKA (*Ochotona macrotis*)

Several were seen feeding during the day on small crags, rock outcrops and narrow gorges in the mountains of the northeast.

HIMALAYAN MARMOT *Marmota himalayana*

Marmots occur throughout the project area, mainly in alpine meadow habitats but also to a lesser extent in alpine steppe. They were absent from wetland habitats and areas of *Kobresia* marsh-meadow, but present in drier raised areas within wetlands. They were seen up to 4800m. Young animals were observed outside their burrows for the first time at the end of July. Marmots are not hunted for their fur or meat in the Project Area.

TIBETAN HAMSTER *Cricetulus kamensis*

Colonies were recorded in damp areas around lakes on the steppe north of Suojia; Tsozhaton Black-necked Crane PA; and at the western end of Bazgonka steppe.

SMALL MAMMALS

A few small mammals, including voles, hamsters and a mouse, were observed but not identified to the species level. The mouse was seen at the entrance to a small cave and bore a close resemblance to the Sichuan jumping mouse (*Eozapus setchuanus*), which has been recorded in this part of the Qinghai-Tibet Plateau. Another specimen was reported by a small UYO team conducting a field survey on the north bank of the

Yangtze, adjacent to the Project Area. Additional small mammal species recorded in south-west or south-central Qinghai that may occur in the Project Area include long-tailed hamster (*Cricetulus longicaudatus*), three species of voles (*Lasiopodomys fuscus*, *Microtus irene*, *M. leucurus*) and two pikas *Ochotona gloveri*, and *O. ladacensis* (Zhang 1997; China Species Information Service database maps). One species recorded widely on the Plateau, the zokor (*Myospalax baileyi*) is apparently absent from the Project Area.

3.3.2 Birds

48 bird species were recorded in the Project Area. Two of these were vagrants or accidentals and one was a passage migrant. The remaining 45 species were either confirmed breeders or presumed to be breeding. One species that was expected but not recorded was Tibetan sandgrouse (*Syrrhaptes tibetanus*). The list of species recorded excludes an unknown number of passage migrants: local people described a large increase in the number of waders and waterfowl present at Tsozhaton and other wetlands during spring and autumn. Bird species diversity in the Project Area is much lower in winter. Only 14 species were seen during the November field visit: goosander (*Mergus merganser*), golden eagle (*Aquila chrysaetos*), lammergeier (*Gypaetus barbatus*), Himalayan griffon (*Gyps himalayensis*), upland buzzard (*Buteo hemilasius*), raven (*Corvus corax*), red-billed croun (*Pyrrhocorax pyrrhocorax*), horned lark (*Eremophila alpestris*), Tibetan lark (*Melanocorypha maxima*), tree sparrow (*Passer montanus*), white-rumped snowfinch (*Pyrgilauda taczanowskii*), red-necked snowfinch (*P. ruficollis*), Tibetan snowfinch (*Montifringilla adamsi*), and Hume's groundpecker (*Pseudopodoces humilis*). All these are assumed to be resident. One bird, black-necked crane, was identified as a key species.

Black-necked Crane (*Grus nigricollis*) Local: *tron-tron*. Chinese: *hei-jin-he*

Seventeen pairs and three juveniles were counted at Tsozhaton Black-necked Crane LPA and seven pairs with one juvenile at Lirin Tsozhaton LPA. None were observed at other small wetlands and no other breeding sites were reported by local sources. Black-necked cranes are endemic to the Qinghai-Tibet Plateau with a global population estimated at 5600-6000 and declining, due to loss of wetland habitats and increased human activity (BirdLife International 2001). This total of 48 adult birds in the Project Area thus represents less than 1% of the world population, but is still one of the larger breeding populations in Qinghai when compared with data on known breeding sites in BirdLife International (2001). In the Project Area, eggs were traditionally collected for food and the legs were utilised as horse whips though the birds themselves were not eaten. These activities have now reportedly ceased and there are no obvious threats to the Project Area population. Breeding success as seen on the field trip was low, though some young may have been missed or still in the nest. Local inhabitants blamed high water levels in spring that destroyed or flooded nests. Other possible explanations could be failure of adults to nest, failure of eggs to hatch or subsequent predation. A low proportion of young birds has been reported elsewhere: 40 adults with 5 young at one site and 105 adults with 11 young at another (BirdLife International 2001). A variety of wetland habitats including *Kobresia tibetica* marsh were used in the Project Area. Cranes also foraged on drier ground surrounding both wetland sites. Black-necked crane is listed as Endangered in the *China Red Data Book* (Zheng & Wang 1998) and as Vulnerable in the *2002 IUCN Red List of Threatened Species* (IUCN 2002). Recommendations for conservation are included in the sections covering the two LPAs.

Great Crested Grebe (*Podiceps cristatus*) At least 30 pairs observed on the larger lakes at Tsozhaton BNC PA on 18-19 and 30 July. Nest sites were located on small 'islands' of vegetation and several birds were still sitting on eggs. A few parties of unfledged young were also present.

Little Egret (*Egretta garzetta*) One bird was seen at Tsozhaton BNC PA on 18-19 and 30 July and is presumed to be regarded a vagrant. Little egrets are common breeding species in southern China (MacKinnon & Phillipps 2000) and the Project Area is well outside its normal breeding range.

Bar-headed Goose (*Anser indicus*) Present at Tsozhaton BNC PA, with a maximum of 650 on 19 July, including some juveniles. About 75 were present at Lirin Tsobjia Wetland Protected Area in mid-August.

Ruddy Shelduck (*Tadorna ferruginea*)

A widespread breeding species. Seen at Tsozhaton and Lirin Tsobjia wetlands (maxima of 150 and 50 respectively) and on small lakes throughout the Project Area. Small parties were also seen along the Mug Chu river above Suojia township where they appeared to be breeding on the cliffs of a small gorge.

Goosander or Common Merganser (*Mergus merganser*)

Seen on the Mug Chu river where they appeared to be breeding on the cliffs of a small gorge above Suojia town. Also seen on the Bang Chu river in the northeast of the Project Area and Tsojalun pool near the confluence of the Mug Chu and Jiong Chu rivers.

Lammergeier (*Gypaetus barbatus*)

Seen regularly in mountain areas. Listed as Vulnerable in the *China Red Data Book* (Zheng & Wang 1998). A category I protected species in China.

Himalayan Griffon (*Gyps himalayensis*)

Seen regularly in mountain areas. Listed as Rare in the *China Red Data Book* (Zheng & Wang 1998).

Upland Buzzard (*Buteo hemilasius*)

Seen in small numbers throughout the Project Area and nesting on cliffs at Pomopondang.

Golden Eagle (*Aquila chrysaetos*)

A few were seen in Tramkar Rasan mountains. Listed as Rare in the *China Red Data Book* (Zheng & Wang 1998) and in the first category of protection.

Common Kestrel (*Falco tinnunculus*)

One family party, pellets and a probable nest site were found on Pomopondang Ridge.

Saker Falcon (*Falco cherrug*)

A rather sparse breeder. Family parties and alarming adults found on Pomopondang Ridge and cliffs near Suojia town. A family party seen on cliffs near Jiongchu Bridge. Single birds were seen hunting on several occasions over meadow and steppe. Listed as Vulnerable in the *China Red Data Book* (Zheng & Wang 1998).

Tibetan Snowcock (*Tetraogallus tibetanus*)

A party of 15 including juveniles was observed on a crumbling rock and scree slope of Dorje Ondra mountain, south of Suojia township and birds were seen and heard throughout the Tramkar Rasan mountains.

Lesser Sand Plover (*Charadrius mongolus*)

A widespread breeding bird in the Project Area in small numbers, frequenting wetlands, lakes and small temporary pools in the steppe and meadow zones. Several alarming birds were seen as well as family parties.

Common Sandpiper (*Actitis hypoleucos*)

A pair was seen several times on shingle banks along the Mug Chu River in the vicinity of Suojia township.

Redshank (*Tringa totanus*)

A very common breeding bird at Tsozhaton BNC PA. A few pairs were present at Lirin Tsobjia PA and other small lakes.

Wood Sandpiper (*Tringa glareola*)

Three individuals, presumably non-breeders or early passage migrants, were seen at Tsozhaton BNC PA.

Pallas's Gull (*Larus ichthyaetus*)

A family party and 2-3 other adult birds were seen at Tsozhaton BNC PA. A pair and a juvenile were together on a pool at Lirin Tsoobja PA as well as one immature and 2 adults in the upper valley of the Bang Chu.

Brown-headed Gull (*Larus brunnicephalus*)

An adult pair and a juvenile were seen together on a pool in Tsozhaton BNC PA, and had presumably bred there.

Common Tern (*Sterna hirundo*)

A fairly common breeding bird with at least 50 pairs at Tsozhaton BNC LPA, (10 pairs) at Lirin Tsoobja Wetland LPA and three pairs on an island in a small lake, Tsojalun, on Dilangaton. A few birds were seen in early August in Mugchu in river valleys up to 4700m.

Hill Pigeon (*Columba rupestris*)

Small numbers were seen throughout the area.

Little Owl (*Athene noctua*)

A pair of alarming adults with a juvenile were seen in the Mug Chu valley, just south of Suojia town.

Hoopoe (*Upupa epops*)

A few birds were seen, on Dilangaton steppe and other locations.

Tibetan Lark (*Melanocorypha maxima*)

Common in all *Kobresia tibetica* marsh-meadows and the Tsozhaton wetlands. Several nests were found with unfledged and near-fledged young.

Oriental Skylark (*Alauda gulgula*)

Seen at Tsozhaton and on the steppes around Suojia town.

Horned Lark (*Eremophila alpestris*)

An abundant breeding bird throughout the project area.

Pale Sand Martin (*Hirundo diluta*)

Breeding at several localities in the project area in larger valleys with steep sand banks.

Asian House Martin (*Delichon dasypus*)

Several pairs were found breeding on cliffs in Yachu and Mugchu.

Richard's Pipit (*Anthus richardi*)

Three were seen in hilly steppe in the vicinity of Suojia town.

Citrine Wagtail (*Motacilla citreola*)

Two family parties were seen at Tsozhaton.

Robin Accentor (*Prunella rubeculoides*)

Occurred occasionally in mountains and hilly areas.

Alpine Accentor (*Prunella collaris*)

Seen at three localities in the higher parts of Tramkar Rasan. One family party with four young was seen at 4820m.

Black Redstart (*Phoenicurus ochrurus*)

An abundant breeding bird present in all habitats throughout the project area, though less common in open steppe habitats.

White-winged (Güldenstadt's) Redstart (*Phoenicurus erythrogaster*)

A few adults and juveniles were seen at higher elevations, notably Tramkar Rasan and Jiongchu.

Wallcreeper (*Tichodroma muraria*)

Three individuals were observed on cliffs and gorge walls in Tramkar Rasan.

Black Drongo (*Dicrurus macrocerus*)

One bird was watched at close range on Dilangaton steppe on 14 July. This is a lowland species normally found below 2000m and the Project Area is well outside its normal range. It had probably overshot on the spring migration.

Hume's Groundpecker (*Pseudopodoces humilis*)

A very common resident species, widely distributed in the Project Area.

Red-billed Chough (*Pyrrhocorax pyrrhocorax*)

Recorded in all mountain areas. A flock of 35 birds was seen in Tramkar Rasan.

Common Raven (*Corvus corax*)

Widely distributed in small numbers throughout the Project Area.

Eurasian Tree Sparrow (*Passer montanus*)

Several pairs were breeding in Suojia township.

Tibetan Snowfinch (*Montifringilla adamsi*)

Fairly common in Tramkar Rasan.

Prince Henri's Snowfinch (*Montifringilla henrici*)

A small number of this species, recently split from white-winged snowfinch (*Montifringilla nivalis*), were seen at elevations of 4800-5000m in mountains in Yachu.

Plain-backed Snowfinch (*Pyrgilauda blanfordi*)

A local and uncommon species in the Project Area, seen by lake edges at Tsozhaton and the steppes north of Suojia township.

Red-necked Snowfinch (*Pyrgilauda ruficollis*)

A common and widespread breeding species.

White-rumped Snowfinch (*Pyrgilauda taczanowskii*)

A common and widespread breeding species.

Brandt's Mountain Finch (*Leucosticte brandti*)

Fairly common in Tramkar Rasan and other mountains.

Great Rosefinch (*Carpodacus rubicilla*)

Only one individual was seen in the upper part of Gyenze Lungpa in Tramkar Rasan mountains.

Red-fronted Rosefinch (*Carpodacus puniceus*)

Several were seen and heard in rocky gorges and steep-sided mountain valleys in Tramkar Rasan.

3.3.3. Reptiles and Amphibians

The only species recorded was a toad-headed agama (*Phrynocephalus erythrurus*) which occurred commonly in sandy steppe habitats. According to local people, no snakes or amphibians occur in the Project Area. The absence of amphibians is surprising given the presence of extensive wetlands and the fact that the Alpine frog (*Altirana parkeri*) is reportedly common in the lakes of southern Chang Tang (Liu 1999).

3.4. Local Protected Areas (LPAs)

Five local protected areas have been designated within the Project Area by UYO and the Suojia district authorities with some advice from Plateau Perspectives, a Canadian NGO. Four of these are intended to protect a key species and one is a general wetland area. A sixth LPA intended to protect wild yaks is situated on the north bank of the Yangtze, outside direct control of the Suojia district authorities and outside the Project Area. UYO are seeking to manage it in cooperation with the local herder community.

None of these LPAs has any infrastructure or trained staff. No management plans have been prepared and there is no budget allocation. With the exception of a marker post at the start of the Kiang LPA, boundaries are not marked on the ground, and in some cases are not precisely defined. Size estimates for each one were calculated during the field visit from ONC and TPC maps. The principal management activity undertaken to date has been the introduction of some grazing restrictions, which have helped the key species. A limited amount of baseline monitoring is carried out annually by members of the EPC. Management priorities and implications for local herders were discussed in each LPA during the course of the field visit. Ten days were spent in the Snow Leopard LPA, plus three days in the adjoining area to the southeast. Six days were spent in the Kiang LPA but only one in the Tibetan Antelope LPA because of access difficulties. The Black-Necked Crane LPA was surveyed over five days, and Lirin Tsojja Wetland PA over three days.

3.4.1. Snow Leopard Local Protected Area

The Snow Leopard LPA covers approximately 350 km² of the Tramkar Rasan mountains in the north of Soujia district. These mountains run northwest-southeast and lie between the Mug Chu and Ya Chu rivers. They are bordered on the north by the Yangtze River. The range contains rocky peaks and ridges and sections of gorge. Summits reach 5300m in altitude. Vegetation consists predominantly of alpine meadow, including patches of *Kobresia tibetica* marsh-meadow.

One snow leopard was seen and sign was detected throughout the area. Blue sheep, an important prey item, were numerous. Also recorded were wolf, red fox, Tibetan fox, stone marten, brown bear, Himalayan marmot, black-lipped pika, large-eared pika and other small mammals. White-lipped deer formerly occurred but a search of one known locality failed to find any sign of current presence but the species may survive in small numbers in remote valleys. Wild yak also formerly occurred in this area and could conceivably recolonise from the northwest. Avifauna included lammergeier, Himalayan griffon, golden eagle, Tibetan snowcock, red-fronted rosefinch, three species of mountain finches, Asian house martin, and Tibetan lark.

There are few human inhabitants in the mountains and grazing levels are correspondingly low, though much higher round the margins. On the initiative of UYO and Suojia EPC, livestock grazing in the whole Drolhochen sub-catchment was abandoned three years ago and the area left alone for snow leopards and blue sheep. Another catchment, Gyenzin Lungpa is also not grazed at present, though in this case as a result of its

remoteness. The vegetation in these valleys is now in excellent condition, as shown by the extent of cover, intact tips and shoots, presence of litter from previous years. The consequences for the vegetation composition of the cessation of livestock grazing are unknown and deserve research. The three transects with the highest density of snow leopard sign and densest blue sheep populations occurred in Drolhochen.

Evaluation: The LPA consists of the whole of a large mountain block between the Yangtze and the Ya Chu which contains the main snow leopard population in the Project Area and a secure prey base. Snow leopard sign and a good blue sheep population were found in the adjacent mountains to the southeast across the Ya Chu so the local protected area could be extended in that direction or it could be zoned as a buffer. Grazing pressure and human disturbance are at a low level in the interior, due in part to its remoteness. There are no current threats to the snow leopard population in the area.

Recommendations:

- Monitor the snow leopard (by sign surveys) and blue sheep populations
- Monitor vegetation succession in the no-grazing zone and graze periodically if needed
- Survey adjacent mountain blocks for snow leopard presence
- Survey upper Gyenzin Lungpa and adjoining sub-catchments in the interior of the massif for the presence of white-lipped deer

3.4.2 Tibetan Antelope PA

Situated in the Bazgonka steppe, between the Mugchu river and the Yangtze, with an area of approximately 1000km². The terrain consists of a gently undulating shallow plain sloping down to the Baz Chu river and bounded on the north and south by hills and mountains. Elevations are 4400-4500m. Apart from some alpine meadow at the eastern end, habitat is predominantly sandy steppe. A narrow band of damper grassland occurs along the Baz Chu river containing *Littledalea racemosa*, *Elymus nutans*, *Carex* sp., *Carex* spp., *Kobresia capillifolia*, *Triglochin palustris*, *Myricaria prostrata* and various herb species.

Sixty-five Tibetan antelopes, all males, were seen and many tracks observed (see species account). Tracks showed that young may have been born there this year though females do not normally give birth in the area, returning northwards to traditional calving grounds in Kekexili before the Yangtze River ice melts. Tibetan gazelle, kiang, black-lipped pika and Himalayan marmot were also recorded and fox droppings were found. There were many local reports of wolves.

Grazing is officially banned in the LPA on the initiative of the EPC and Suojia district authorities, though a few sheep droppings were found, perhaps from stray animals. The habitat was in generally good condition. The area is still vulnerable to poaching despite the efforts of the local herders to monitor and combat illegal activity. Vehicle patrols are needed during the winter, especially in the western sector of the LPA closest to the main road.

Two further problems affect the site. Firstly, the winter road connecting Suojia with the main Golmud-Lhasa highway runs the length of the LPA, and is used by traffic from several districts. This inevitably results in some disturbance and allows poachers to gain access from the western end. UYO and Suojia district authorities have proposed an alternative route along the foot of the mountains on the southern edge of the LPA to divert through traffic away from the area used by the Tibetan antelopes. This would also benefit local residents by providing a transport link to the district centre at Suojia. Support from the county authorities for this proposal and the resources needed to implement it are essential. Proposals have been made to extend the highway into Suojia from the county centre at Zhiduo, which is currently being upgraded, westwards to link up with the Golmud-Lhasa road. This would require construction of a road bridge over the upper Yangtze but if this were approved it would be even more important to ensure the route ran outside the LPA and not through its centre as at present.

Secondly, UYO has reported unofficial encroachment by families from the Tibetan Autonomous Republic into the southwest of the LPA where they have built unauthorised houses. This is a source of permanent disturbance and possible poaching and needs resolving at the level of the provincial authorities.

Evaluation: The LPA covers all the current range of Tibetan antelope in the Project Area and a homogeneous tract of steppe habitat. The Tibetan antelope population is small in relation to the global total but in view of its Endangered status and the declining numbers across its range, it is important to give protection to all populations. This is one of the few populations left at the eastern end of the range and its importance may grow if there is an increase in disturbance from the railway construction. There is room for future expansion eastwards across Mug Chu onto Dilangaton where the species formerly occurred, should the population build up sufficiently.

Recommendations:

- Survey and census Tibetan antelopes over the whole LPA to establish the size of the population
- Conduct a survey during the rutting season to assess the importance of the LPA
- Work with the Zhiduo county authorities on realignment of the winter road
- Address the problem of encroachment through the provincial authorities
- Implement anti-poaching measures especially in winter

3.4.3. Kiang LPA

This is located in the upper course of the Jiong Chu river in the southeast of the Project Area. An inscribed stone pillar marks the western end of the LPA at Jiongchu Bridge on the main road into Suojia and it extends from there along the southern bank upstream to the headwater springs. The total area covered is about 750km². Elevations range from 4500m to over 5000. It is possible to drive over the eastern third of the area, but the rest is accessible only on horseback or on foot. Kiang are common throughout the area. Local inhabitants said they were especially numerous in the vicinity of Chungu Ama Spring, where “thousands” could be counted in winter. Brown bear, white-lipped deer, wolf and Tibetan fox were reported to occur in the mountains in the upper Jiong Chu. Local people said that kiang numbers had increased since the ban on hunting was instigated and these were perceived to pose a threat to livestock through competition for grazing. A few people expressed regret they were no longer allowed to hunt kiang. According to the headman, the human population of Jiongchu *mu-wei-hui*, had dropped by over 70% since 1985. Nevertheless, grazing pressure in the western end was still high, but high numbers of kiang were still present.

Evaluation: The site includes the best area for kiang in the Project Area and includes well over 50% of the population. In terms of Tibetan Plateau biodiversity in general, this is the least important of the LPA as kiang are not currently considered to be threatened.

Recommendations:

- Monitor the kiang population and assess the rate of increase
- Research dietary overlap between livestock and kiang
- Consider some form of compensation for local herders if competition is shown to be significant

3.4.4. Black-Necked Crane LPA

This comprises the Tsozhaton wetland, situated in a shallow bowl on the east bank of the Mug Chu River south of Suojia township. It consists of lakes, marshes and wet steppe at elevations around 4475m. It covers an overall area of about 80km² in total. It is bounded on the north and south by low mountains rising to about

5000m and on the west by the wide, muddy bed of the Mug Chu river. The summit of Dorje Ondra peak (4875m) on the northern side gives an excellent view of the site. Vegetation communities present in the PA are listed in the habitats and communities section above. It is possible to drive or ride round the margins, but progress in and around the centre of the site is only possible on foot, though free access is hindered by deep water in some lakes and channels.

Systematic foot surveys and scans from five higher viewpoints counted 17 pairs of black-necked cranes present on July 30 but only four young. It is likely that some had either not hatched or left the nest as several pairs were behaving in a territorial manner: alarming on our approach and appearing agitated but not moving far away from a site. Some cranes were seen foraging on several days on drier slopes above the wetlands: this fact should be taken into account when formulating management prescriptions for the area. Other species present included bar-headed goose (maximum 625 on 19 July, including immatures); ruddy shelduck (at least 150 seen including breeding pairs with young); common tern (>50 pairs); redshank (>100 pairs); lesser sand plover (at least 10 pairs); great crested grebe (30 pairs, several on the nest, some with parties of unfledged young); brown-headed gull (one pair with an immature bird); Tibetan larks were common in all areas of *Kobresia tibetica* marsh. Other passerines recorded and presumed to be breeding included citrine wagtail, oriental skylark, red-necked snowfinch, white-rumped snowfinch, and plain-backed snowfinch. Upland buzzard and saker falcon hunted over the site. Two Pallas's gulls and a little egret were also present. The latter bird was some way outside its normal breeding range. Local people reported large numbers of passage migrants stopping over in spring and autumn. Mammals observed were kiang, Tibetan gazelle, wolf, Tibetan fox, Himalayan marmot, black-lipped pika and Tibetan hamster. Blue sheep occur on the ridge flanking the northern side of the wetlands and were seen from the site.

The site is in good condition with extensive areas of ungrazed emergent and marginal vegetation and little grazing in the central area. Cranes are counted annually by local members of the EPC. Proposed construction of a house on a ridge of higher ground in the centre of the wetland had been prevented in the interests of reducing disturbance. Grazing is subject to some controls. Collection of crane eggs and those of other species has been banned. There are few problems affecting the site. At present, free-ranging herders' dogs may cause some disturbance to water birds or even mortality, but following discussions, the local herders agreed to address this. Local EPC members also expressed the need for a reserve sign at the entrance to the area, and survey equipment such as telescope, tent and identification material. An observation tower was also said to be desirable.

Evaluation: This is the most extensive and most varied wetland in the Project Area. The primary interest is the largest breeding crane population in Suojia. There are good numbers of other breeding species and passage migrants and several mammals also occur. Botanical diversity within the LPA is high and presumably also reflects invertebrate diversity. Present boundaries incorporate the whole wetland although the fact that cranes regularly forage on drier ground around the edges of the wetland needs to be taken into account when formulating a detailed management plan.

Recommendations:

- Continue annual monitoring of crane population (number present, number of nests, number of young)
- Provide survey equipment (telescope, tripod, identification material) for local monitors
- Erect signs at site boundary
- Cost out the construction of a simple tower hide to facilitate monitoring of the site
- Prevent local herders' dogs from running free on the site

3.4.5. Lirin Tsobja Wetland LPA

This is situated in the northeast of the Project Area in the upper valley of the Bam Chu and consists of c.150 pools and small lakes set in an area of *Kobresia tibetica* marsh-meadow at elevations of 4700-4800m. A low ridge of drier ground runs down the centre of the site. The area covered is about 75km². Access around the

site is straightforward on horseback or on foot.

Seven pairs of black-necked crane were counted, but only one young bird. Local inhabitants blamed the low number of young on high water level in spring which had flooded nests. Other species present included bar-headed goose (75); ruddy shelduck (c.50 including two pairs with 4 and 9 young respectively); common tern (>10 pairs); redshank (c.10 pairs); lesser sand plover (5 pairs); Pallas's gull (one pair with a juvenile), and Tibetan larks (common). No large mammals were seen.

The area is grazed by five extended families and heavy grazing is degrading vegetation quality at several points. Some herders complained at the deteriorating quality of the grazing, citing declining amounts of flowers and palatable grasses for their sheep. No management efforts are undertaken though local people said the cranes were not persecuted or their eggs collected and there are no other apparent threats to black-necked cranes.

Evaluation: Site boundaries incorporate the whole wetland and are appropriate. There is a small breeding population of black-necked cranes and other species, though in fewer numbers than at Tsozhaton. Botanical diversity is also lower. If the condition of the site is to be maintained in the long-term, the issue of high stocking density will need to be addressed. Discussions with local authorities produced several possible solutions: greater local mobility of herds to ensure the area is not subject to year-round grazing, fewer head of livestock present, or the temporary transfer of the current herders to nearby areas left vacant by emigration to allow the vegetation to recover.

Recommendations:

- Continue annual monitoring of crane population (number present, number of nests, number of young)
- Provide survey equipment (telescope, tripod, identification material) for local monitors
- Draw up a formal agreement with local herders to ensure that cranes are not disturbed or persecuted
- Resolve the issue of high stocking density through one or more of the means listed above

3.4.6. Conclusions and General Recommendations

The existence of Local Protected Areas further demonstrates a desire at local level to contribute to biodiversity conservation and the currently designated sites promote conservation of key species and habitats. A potential new candidate site for LPA status would be the white-lipped deer site on Churazaley Mountain. All sites need effective management and adequate resources to meet their objectives. Necessary measures include:

- List outline prescriptions to safeguard the main biodiversity interest of each LPA, while more detailed plans are prepared
- Fix and map the boundaries of each site
- Draw up full management plans in co-operation with representatives of each local community
- Obtain necessary funding to implement plans, including payment for local people involved in management activities
- Provide a training programme for all local herders concerned with management

4. HUMAN LAND USE

4.1. Livestock grazing

Livestock grazing represents the biggest human impact on biodiversity in the Project Area and some knowledge of the grazing history helps to inform an assessment of its impact. Pastoralism has been a feature

of the Qinghai-Tibet Plateau for centuries but the length of time it has affected the Project Area is not fully documented. It has been suggested that animal husbandry was first introduced to Suojia following the establishment of the district in 1972 and that prior to that the area was sparsely inhabited by semi-nomadic tribes of Tibetan hunters (Foggin 2000; Anonymous 2001). However, many people interviewed during the field visit, especially residents of Tramkar Rasan, stated that the land had traditionally belonged to the Yara tribe, who had grazed it for generations, with some informants referring to a period of at least 300 years. Many individual recollections extended back beyond a quarter-century time-scale and several specific instances were cited of parents, grandparents and great-grandparents grazing the same pastures. This weight of personal testimony, which was supported by the UYO, indicates that animal husbandry has a long history in some parts of the Project Area, though others were uninhabited until relatively recently.

In 1958, during events now referred to as 'liberation,' the People's Liberation Army sent all the inhabitants of the Suojia area back to Zhiduo county centre, in part to assist with construction work. Suojia was formally established as an administrative unit in 1966, originally with its centre in Yachu in the northeast. In 1972 the administrative centre was moved to its current location on the east bank of the Mug Chu river and most of the population returned (Foggin 2000). It seems certain that the density of settlement increased at this time. The whole district therefore remained ungrazed by livestock for a period of about 14 years (8 years for the northeast quarter). A commune system was established and livestock were collectively owned though still managed utilising a traditional seasonal grazing pattern. At the same time, in the first years of the administration, organised hunting brigades were set up to feed the people.

Two events in 1985, an exceptionally severe snowstorm and a major change in legislation, had a significant effect on the rangelands and wildlife of the Project Area. The 1985 snowstorm caused heavy mortality to domestic animals and forced many families to leave Suojia. More people have left the Project Area since then, motivated in part by a desire for better education and health facilities though the number of people who have moved out is hard to quantify in the absence of any official figures. The headman of Jiongchu *mu-wei-hui* reported that only 144 families were still present out of the 500 who lived there before 1985, a reduction of more than 70%. Foggin (2000) quoted a figure of 4377 people in 856 households in Suojia, but acknowledged that this included people who were known to have left. According to the Suojia authorities, 167 families moved out of the area between 1995 and 2002, itself a decrease of 19.5% on these figures. UYO sources believe the human population decline has now stabilised, owing to a higher birth rate

The principal objective of the Grassland Law (PRC 1985) was to return communally owned livestock herds to private ownership, with families being allocated use of certain pastures. This was accompanied by initiatives to improve herders' living conditions, including construction of a winter house for each family and winter yak shelters. The main rationale was to reduce vulnerability to severe winter conditions and to make it easier to provide social services, but these measures also reflected an underlying lack of confidence by the government in the efficacy of traditional grazing management systems (Richard 1999).

Government initiatives also encompass subsidised fencing of pastures and mass poisoning of pikas and other small mammals, using chemicals such as zinc phosphide. Fencing of large areas impedes the movement of large mammals and may restrict their access to preferred grazing. Fencing is currently estimated to affect less than 5% of the Project Area, in sharp contrast to some districts to the east where almost all the rangeland has been fenced off. The objective of pika poisoning campaigns is to eliminate species perceived to be damaging rangeland, although many scientists dispute their role as a pest species. The possibility that pikas may make a positive contribution to ecosystem dynamics, such as improving soil aeration and drainage through burrowing has not been researched. Destruction of pika colonies is also damaging to biodiversity by removing a major prey item for smaller carnivores and birds of prey and introducing the risk of secondary poisoning. No poisoning has been carried out in the Project Area since the 1970s and this activity would be incompatible with any kind of nature reserve status. Programmes such as fencing construction and poisoning campaigns are government-sponsored and it can be difficult to prevent their implementation at local level. The Project Area

has so far escaped much of the wider development affecting rangeland elsewhere on the Plateau. There is no mining or industry, no invasive or alien species have been reported and no land has been converted to agriculture. Nearly 4000km² of rangeland in Qinghai have been converted to agriculture since 1949 (National Academy Press 1992).

No official figures are available for current livestock numbers in the Project Area. It seems a reasonable assumption that the decline in the human population has been accompanied by a parallel reduction in livestock. However, while acknowledging localised reductions, local people felt that on balance, livestock numbers had remained stable or increased slightly over the previous ten years. Traditionally, a small number of male yaks were retained for breeding and the remainder used as pack animals but increased availability of motor vehicles has reduced the need for yak transport. Consequently, male yaks have been sold off for meat or bartered for motor cycles or jeeps over much of the Project Area. The number of horses has also fallen, as people make more use of motor cycles for transport.

There is a wide range in the size of individual herds of yaks and sheep and the size and quality of pastures. Households possessing 100 or more yaks are widely regarded as 'rich', because the surplus animals produced can be sold or bartered. One family of seven persons said their 40 yaks were sufficient to support them, though they wanted more. Grazing pressure is therefore unevenly distributed over the Project Area. Use of summer and winter pastures is no longer enforced and there has been a tendency for families to remain at their winter house all year and a shift away from traditional seasonal grazing patterns in favour of year-round grazing of the same pastures. This also reflects changing aspirations of the herders who wish to enjoy better facilities and remain within reach of a road, as greater use is made of motor vehicles.

One undisputed consequence of the emigration since 1985 is that parts of the Project Area are only lightly grazed or left ungrazed. Some others that have been used for generations remain in good condition and production of palatable species is high, demonstrating the efficacy of traditional systems of rangeland management in some circumstances. The immediate surroundings of most encampments, where animals are kept at night and brought for milking, are subject to heavy grazing and trampling, resulting in heavily worn patches. A strip of bare earth is especially obvious along yak tethering lines. Stock-worn patches may also form on steep slopes where the terrain channels multiple animal trails through a narrow area. Apart from these, only a few localised patches of damaged pasture where vegetation cover had been severely degraded or totally removed, leaving the ground vulnerable to erosion, were seen. Areas damaged by overgrazing are estimated to cover no more than 10% of the district. A larger proportion of the Project Area's rangeland is subject to heavy grazing, detectable through lower mean sward height and a low proportion of intact plant tips. Some of this is deteriorating in quality through removal of herbs and palatable grasses, and over-cropping of standing plants, causing damaged tussocks and lower tussock density. Heavily grazed areas can be restored by reducing or removing grazing pressure for a set period of time, but once they have become totally degraded they are much harder to restore and also inevitably transfer grazing pressure to areas in good condition.

Recommendations:

- Map rangeland condition, use (non-grazed, seasonally grazed, all-year grazed) and stocking density
- Identify maximum sustainable grazing levels and use these as examples of proven good practice
- Address localised overgrazing and deteriorating range condition through rotational use of pastures or lower stocking densities
- Test the effectiveness of short term grazing exclusion by erecting exclosures and monitoring plant growth and production within and outside these
- Pursue all possible alternative income options (see section 5)
- Oppose any renewal of pika poisoning campaigns
- Limit fencing of extensive areas

4.2. Turf cutting

A second direct impact involves the long-established custom of cutting turf blocks to build low walls lining the inside of tents and to make internal compartments for storing fuel etc. The size of blocks varies but they typically measure 60x30cm in area and about 25cm deep. The quantity of blocks used per tent varies between 60 and more than 100. Thus one family can remove 10-20m² of the sod layer for each camp. The blocks are left on the site when the encampment is moved in spring and autumn. Turf blocks are also used in construction of outbuildings and houses, and demand has been further increased more recently by their use to mark out vehicle tracks and build snow walls to protect roads over high passes. Turf removal reduces vegetation cover and risks exposing the soil to erosion. When carried out on a large scale there are also likely to be unknown effects on hydrology, with the soil especially deep sod layer of the marsh meadow acting as a water-holding sponge. In some parts of the Qinghai-Tibet Plateau, large quantities of turf blocks are transported by truck for use elsewhere. The remoteness of the Project Area has so far protected it from large-scale exploitation of this resource.

4.3. Hunting and Attitudes to Wildlife

Subsistence hunting for meat and skins has always been a feature of life on the Qinghai-Tibet Plateau, with some hunting for trade, notably musk deer for their musk and deer for their antlers. When Suojia township was first established, organised hunting brigades were set up to provide people with food and the scale of hunting in the Project Area intensified. It is likely that this contributed to the disappearance of wild yaks from the Project Area and the decline of some other species. These brigades have since been disbanded, though some local people continued to hunt blue sheep and kiang for meat and skins in small numbers until recently. One interviewed said they used to shoot around 15 kiang and 18-20 blue sheep per year for meat. Both these species still occur in large numbers in the Project Area and so the effects of hunting have not had a long-lasting effect on their numbers. Black-necked crane eggs used to be collected for food and their legs used as horsewhips. The Suojia district authorities banned hunting in 1998 and weapons were confiscated on the orders of the government during winter 2001-2002. No hunting trophies were seen during the field visit and no evidence found that the official ban was being ignored. The only exception is the poaching of Tibetan antelopes during winter, which is known to have occurred and which was blamed exclusively on people from outside the Suojia area.

Direct exploitation of Plateau biodiversity also encompasses collection of plants for use in traditional medicine and caterpillar fungus (*Cordyceps sinensis*) for use in an alcoholic drink. Medicinal plants are collected in the Project Area but on a local or personal basis, not systematically or commercially and no evidence of resulting damage to the vegetation of the Project Area was found. The latter was virtually unknown, probably because of transport difficulties.

Local people's attitudes towards conservation of biodiversity were found to be generally positive. Some people regretted that they could no longer hunt for meat, but most accepted the ban on hunting and agreed it was important to protect wildlife, which they viewed as an integral part of their environment. Some additionally cited Buddhist religious beliefs against killing animals. The respect shown for wildlife extends to small species. For example, drivers always did their best to avoid pikas that ran in front of vehicles and birds flying up from the roadside and there is a formal commitment to biodiversity considerations through the establishment of the EPC and its link with UYO. Most concern was expressed in Jiongchu, where people were concerned about rising numbers of kiang which they felt were competing for grazing with their livestock. The collection of weapons has provoked some resentment among herders who felt they no longer had any protection against bears and wolves. Herders said that a shot fired in the air was enough to deter an approach by a bear and there seemed no overt desire to kill them. Bears were feared out of proportion to their abundance in the Project Area because of their attacks on houses and tents and occasional attacks on people

that had caused fatalities. A certain level of predation on livestock was accepted as one of the risks of a herding lifestyle. Wolves were seen as the greatest threat on account of their distribution across the Project Area, with snow leopards restricted to rocky mountain areas. Recommendation:

- Investigate the practicality of non-lethal methods of bear control such as flares, starting pistols or thunderflashes

5. THE FUTURE OF SUOJIA'S RANGELAND

5.1 San Jiang Yuan Nature Reserve

The final status of the Project Area within the San Jiang Yuan Nature Reserve has important implications for future management. The reserve covered a vast area of more than 300,000km² when first designated, but has now been reduced to around 158,000 km². Boundaries and land zoning have not yet been finalised and await national government ratification. One of 19 designated core zones has until recently included most of the Suojia Project Area, but it now appears that it may after all be excluded. A legal requirement of core zone status is that they should contain no human inhabitants, something that would necessitate relocation of the people currently living within the affected areas of Suojia. Several thousand people across the whole San Jiang Yuan NR may ultimately have to move elsewhere. Although compensation is reportedly available, no destination has been identified, a major consideration, as most or all of Qinghai is already settled and heavily grazed. There is political opposition at district, county and prefecture levels to any transfer of local people. However, if Suojia is eventually excluded from the core zone, a second problem may arise in that parts of the district currently unoccupied could be seen as providing an option for resettling people displaced from nearby areas.

5.2. Improving Livelihoods

The local economy of the Project Area is almost totally reliant on animal husbandry to meet daily needs and produce any surplus so it is crucial that ways are found of managing the rangeland in a sustainable way to provide for the needs of livestock and wild animals. There are currently few alternative livelihood options in the Project Area and other income sources and economic diversification are needed in order to reduce dependency on rangelands as well as address issues of poverty and social welfare. Many children in Suojia do not attend school, even the two tent schools set up to cater for remote communities. Better take-up of education and more facilities would encourage adoption of alternative career options and a first step should be educating parents on the value of education for their children's future.

There is scope for increasing the volume of trade in herding produce - horses and other livestock, meat, hides, and dairy products, especially butter – through co-operatives or development of small businesses. Improvements to transport links would facilitate access to potential markets, and enhance the possibility of obtaining the best economic return for products. Two other possibilities for alternative income generation are handicrafts and ecotourism. Handicraft possibilities in the Project Area are currently limited and their development will require a programme of vocational training. Wildlife-based ecotourism can contribute to the local economy if it results in a direct input of financial resources through payments for local services, accommodation and supplies. However, the long journey over poor roads needed to reach Suojia, the difficulties associated with travel around the district, restricted time period when tours are viable, and lack of facilities mean that the area is currently unlikely to attract more than a few specialist groups. Around one third of villages in Qinghai have some kind of small business enterprise (Foggin 2000) but there are none in Suojia at present. The introduction of small businesses will also need education and training as well as provision of credit and banking facilities. At present, the nearest bank is located in the county centre at Zhiduo, a day's drive from Suojia. The journey can take longer in summer and considerably longer on horseback. The presence of a bank in Suojia would also increase options for herders by allowing them to sell surplus animals and deposit the proceeds for use when needed, such as for purchasing replacement livestock in the event of severe winter mortality or acquiring consumer products. Everything should be done to ensure that management of the San Jiang Yuan Nature Reserve provides local employment opportunities and uses

locally sourced goods and supplies where possible.

If access to natural resources is restricted, some form of compensation may be needed, such as subsidies for reduced stocking levels. Innovative ways of compensating local communities should also be considered. For example, lack of medical facilities was the biggest problem reported during field surveys, particularly in remote areas and the only medical facility is currently located in Suojia township, a long way from many encampments. One means of addressing this problem and simultaneously building support for biodiversity conservation would be to form mobile health teams expressly linked to local conservation initiatives. Teams would consist of doctors and health workers familiar with local conditions and would tour remoter parts of the Project Area during the summer months to provide medical treatment and instruction on basic health care and advice on childbirth. They would be called e.g. ‘Snow Leopard Medical Team’ in the Snow Leopard LPA, or ‘Black-necked Crane Team’ to make clear that they were part of an agreement among local people to conserve wildlife and the environment.

6. CONCLUSIONS

Much of Suojia’s rangeland is in good condition, with light or no grazing, high species diversity, and good production of palatable species. A long history of grazing in parts of the Project Area demonstrates the sustainability of traditional rangeland management systems. Relatively few completely degraded areas were found, but the quality of some heavily grazed areas is deteriorating, and remedial action is needed before they are completely degraded. Apart from 2-3 species of large mammal that have disappeared, bird and mammal communities are intact and representative of the Tibetan Plateau. Important populations of many wildlife species are still present, notably snow leopard, blue sheep, Tibetan gazelle, kiang, Tibetan antelope, black-necked crane and white-lipped deer. The contrast in wildlife diversity and species abundance between the Project Area and adjoining areas to the east is marked. There is a similar difference in rangeland quality and vegetation quality.

People’s attitudes are fundamentally positive and there is an existing administrative infrastructure in the form of the UYO and EPC. Wildlife conservation initiatives undertaken prior to the commencement of the Darwin Project, such as participatory monitoring and zoning of land for exclusive or primary use by key wildlife species, analysis of training needs, and identification of key areas for biodiversity were locally driven and this creates a positive environment for future development of the project and the implementation of actions.

The favourable natural conditions, intact wildlife populations and local support demonstrate that the Project Area can be managed in the long-term in a way that integrates conservation of Tibetan Plateau biodiversity, sustainable rangeland use and the traditional way of life and culture. Such a strategy, supported by UYO, will be best achieved through collaborative, community-based management and adoption of initiatives designed to deal with the specific conditions in Suojia, rather than application of generalised management frameworks.

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References

- Achuff, P. and Petocz, R. 1988. *Preliminary resource inventory of the Arjin Mountains Nature Reserve, Xinjiang, People's Republic of China*. WWF, Gland.
- Anonymous. 1990. [*Qinghai province atlas*]. Qinghai Mapping Bureau, Xining. (In Chinese).
- Anonymous. 2001. Fourth report of phase two of the Biodiversity Working Group (BWG) of the China Council for International Cooperation on Environment and Development (CCICED). Pp. 51-100 In: Schei, P.J., Wang Sung and Xie Yan. 2001. (Compilers). *Conserving China's Biodiversity (II)*. Biodiversity Working Group/CCICED. China Environmental Science Press, Beijing.
- BirdLife International. 2001. *Threatened birds of Asia: the BirdLife international red data book*. BirdLife International, Cambridge.
- Chang, D. 1981. The vegetation zonation of the Tibetan Plateau. *Mountain Research and Development* 1:29-48.
- Chang, D. and Gauch, H. 1986. Multivariate analysis of plant communities and environmental factors in Ngari, Tibet. *Ecology* 67:1568-1575.
- Foggin, J.M. 2000. *Biodiversity protection and the search for sustainability in Tibetan Plateau grasslands (Qinghai, China)*. PhD thesis. Arizona State University, Tempe, Arizona.
- Hou, X. 2001. *1:1,000,000 vegetation atlas of China*. Science Press, Beijing.
- IFAW/WTI. 2001. *Wrap up the trade. An international campaign to save the endangered Tibetan antelope*. International Fund for Animal Welfare, Yarmouth Port, Maryland, and Wildlife Trust of India, New Delhi.
- IUCN. 2002. *The 2002 IUCN Red List of Threatened Species*. IUCN, Gland.
- Lai, C. and Smith, A.T. 2001. Keystone status of plateau pikas (*Ochotona curzoniae*): effect of control on biodiversity of native birds. Pp. 223-230. In: Schei, P.J., Wang Sung and Xie Yan. 2001. (Compilers). *Conserving China's Biodiversity (II)*. [Biodiversity Working Group/CCICED] China Environmental Science Press, Beijing.
- Liu, S. (Chief Editor). 1999. *Flora Qinghaiica*. Vol. 4. Qinghai People's Publishing House, Xining, (in Chinese).
- Liu, W. 1999. *Chang Tang. A high and holy realm in the world*. China Forestry Publishing House, Beijing.
- MacKinnon, J. and Phillips, K. 2000. *A field guide to the birds of China*. Oxford University Press. Oxford.
- Mallon, D.P. 1991. Conservation of large mammals in Ladakh. *Biological Conservation* 56:101-119.
- Mallon, D.P. 1998. *Ecology and conservation of mountain ungulates in Ladakh, India*. PhD thesis. Manchester Metropolitan University.
- Mallon, D.P. and Kingswood, S.C. (Compilers). 2001. *Antelopes. Global Survey and Regional Action Plans, Part 4. North Africa, the Middle East, and Asia*. IUCN, Gland.

National Academy Press. 1992. *Grasslands and grassland sciences in northern China. A report of the committee on scholarly communication with the people's Republic of China*. Office of International Affairs. National Research Council. National Academy Press, Washington D.C.

PRC. 1985. *Grasslands law of the People's Republic of China*. Government of the People's Republic of China, Beijing.

Ren, J. 1986. *An atlas of rangeland and its main plant resources on Qinghai-Tibet Plateau. Volume Qinghai*. Agricultural Publishing House, Beijing.

Richard, C. 2000. Rangeland policies in the eastern Tibetan Plateau. *Issues in Mountain Development* 2000 (4):1-5.

Schaller, G.B. 1998. *Wildlife of the Tibetan steppe*. University of Chicago Press, Chicago.

Schaller, G.B. and Ren, J. 1988. Effects of a snowstorm on Tibetan antelope. *Journal of Mammalogy* 69:63-634.

Schaller, G.B., Ren, J. and Qiu, M. 1988. Status of the snow leopard *Panthera uncia* in Qinghai and Gansu provinces, China. *Biological Conservation* 45:179-194.

Schei, P.J., Wang, S. and Xie Y. 2001. (Compilers). *Conserving China's Biodiversity (II)*. [Biodiversity Working Group/CCICED] China Environmental Science Press, Beijing.

Sheng, H., Ohtaishi, N. and Lu, H. 1999. *The mammals of China*. China Forestry Publishing House, Beijing.

Smith, A.T. and Foggin, J.M. 1999. The plateau pika (*Ochotona curzoniae*) is a keystone species for biodiversity on the Tibetan Plateau. *Animal Conservation* 2: 235-240.

Smith, A.T. and Foggin, J.M. 2001. The plateau pika is a keystone species for biodiversity on the Tibetan Plateau. Pp. 211-221 In: Schei, P.J., Wang S. and Xie Y. 2001. (Compilers). *Conserving China's Biodiversity (II)*. [Biodiversity Working Group/CCICED] China Environmental Science Press, Beijing.

Zhang, Y. 1997. *Distribution of mammalian species in China*. China Forestry Publishing House, Beijing.

Zheng, G. and Wang, Q. 1998. (Chief compilers). *China red data book of endangered animals. Aves*. Science Press, Beijing.

