Article

A Strategy for Conservation of the Tibetan Gazelle *Procapra picticaudata* in Ladakh

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Abstract: *Tibetan gazelle* Procapra picticaudata *is endemic to the Tibetan plateau. During the early twentieth century, it was distributed over a range of c. 20,000 km^2 in Ladakh, India. Although its conservation status is believed to be secure, our surveys initiated in 2000 found that the gazelle's population in Ladakh has undergone a precipitous decline. Today, c. fifty individuals survive precariously in an area of c. 100 km^2 in eastern Ladakh. Population declines have also been reported from Tibet, which remains its stronghold. Local extinction of the gazelle in Ladakh is imminent unless active population and habitat management are undertaken. Management measures, however,*

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are stymied by the lack of understanding of the gazelle's ecology and the causes for its decline. Our recent studies in Ladakh establish that past hunting, particularly in the aftermath of the Sino-Indian war in 1962, and continued disturbance and habitat degradation associated with excessive livestock grazing are the main anthropogenic factors that caused the gazelle's decline. Our studies have also generated an understanding of the important biotic and abiotic habitat correlates of the gazelle's distribution, and the land use and socio-economy of pastoral communities that share the gazelle's range. We review these findings, and based on our research results, outline a species recovery strategy for the Tibetan gazelle.

Keywords: Tibetan gazelle, Ladakh, conservation, population recovery, participation

INTRODUCTION

RANGELANDS ACROSS the world are increasingly seen as being important for wildlife conservation alongside pastoral production. The high altitude Trans-Himalayan rangelands spread over *c.* 2.6 million km^2 of the Tibetan plateau and its marginal mountains are characterised by cold and arid conditions, with a short plant growth pulse during summer. The landscape continues to support a relatively intact assemblage of Pleistocene large wild herbivores (Schaller 1998). Within India, the region is spread over *c.* 186,000 km^2, largely in the states of Jammu and Kashmir, Himachal Pradesh and Sikkim (Rodgers et al. 2000). The human population is sparsely distributed but almost all available pastures are used for grazing. Unlike most other terrestrial landscapes of the country, and, in fact, unlike many other parts of Asia, the wildlife populations in the Trans-Himalaya are not restricted to protected areas, but occur across the landscape (Bhatnagar et al. 2006c). Nevertheless, several Trans-Himalayan wild herbivores and their habitats are critically threatened and have undergone local extinctions and range reductions over the last few decades (Fox et al. 1991; Mishra et al. 2002; Bhatnagar et al. 2006a). Of the eight wild large herbivore species occurring in the Indian Trans-Himalaya, at least four species number less than 500 surviving individuals (Johnsingh et al. 2006). One such species, the Tibetan gazelle *Procapra picticaudata*, which is endemic to the Tibetan plateau, is on the verge of local extinction in Ladakh, with less than 100 individuals surviving precariously in eastern Ladakh today (Bhatnagar et al. 2006a). Its populations are also reported to be declining in Tibet (Schaller 1998). Unless a population recovery programme is initiated urgently, the species is likely to go extinct from Ladakh over the next few years. However, initiation of such a programme is stymied by the lack of understanding of the gazelle's habitat requirements and of the causes of its decline.

Active management of small surviving populations, such as that of the gazelle in Ladakh, becomes necessary if their imminent local extinction is to be averted. At the same time, it is equally important to manage small populations with prudence, since any faulty management can precipitate population extinction. The declining-population paradigm is a guiding framework for designing population recovery programmes and focuses on understanding the causes of population decline and terminating or mitigating the effects of those agents (e.g. demographic, genetic or environmental) (Caughley 1994). On the other hand, the small-population paradigm places emphasis on breeding a small stock from the remnant population and releasing it in the wild, and is particularly useful when the wild population gets too small to manage. It is suggested that conservation strategies, whenever necessary and possible, employ a combination of declining- and small-population paradigms (Caughley 1994). In this article, our first objective is to review the results of our studies on the ecology of the gazelle, the causes of its decline, and the socio-economy and land use of the local people who share the gazelle's habitat. Our second objective is to discuss the implications of our research results for a species recovery programme based on a combination of the small- and declining-population frameworks.

DECLINE OF THE TIBETAN GAZELLE

Our appraisal of archival and current literature indicates that the Tibetan gazelle was relatively common in Ladakh during the early twentieth century when its distribution was spread as far west as the Tsokar basin, and its range encompassed much of the *c.* 20,000 km^2 Changthang region in eastern Ladakh (Burrard 1925; Stockley 1936) (Figure 1). However, by 1980-1990, its range had contracted to *c.* 1000 km^2, and despite such a quantum range reduction, the species continued to be relatively neglected from a conservation viewpoint (Fox et al. 1991; Bhatnagar and Wangchuk 2001). Excessive hunting was the most important cause of the gazelle's precipitous decline in Ladakh (Fox et al. 1991); this is alluded to even by Burrard (1925). In particular, gazelles were heavily hunted by the nomadic Tibetan refugees, and military personnel who arrived in large numbers following the Sino-Indian war in 1962. It appears that during and after the war, an under-provisioned armed force relied on wild ungulates for meat in the remote border areas of Changthang, and the gazelle, occurring on relatively easier rolling terrain, became a common victim. Our interviews of the elders in the herding community revealed that on occasions, entire truck loads of gazelles were hunted in the late 1960s (Bhatnagar et al. 2006b). This period saw similar wildlife decimation in other parts of India as well, after modern weapons and vehicles became available (Gee 2000, Rangarajan 2001), though the extent of damage in Ladakh was probably much higher due to the war and associated developments. The relative impact of hunting in a region where large-scale hunting was not known can be seen as a

major turning point in the history of wildlife occurrence in the region. Hunting, mostly for food, continued until early 1980s, and was subsequently brought under control by the wildlife department of the state (Bhatnagar et al. 2006b). Despite the curtailment of hunting, the gazelle populations apparently continued to decline, and our surveys initiated since the year 2000 established that the last remaining relatively large population of the Tibetan gazelle in Ladakh now survives in and around the Hanle River basin, where *c*. fifty individuals are believed to occur in fragmented populations (Bhatnagar et al. 2006a).

Since the 1950s, the gazelle's habitat in eastern Ladakh has also seen a considerable increase in the intensity of livestock grazing (Bhatnagar et al. 2006c; Namgail et al. 2007b). Influx of Tibetan refugees (who were also livestock herders) into the region, which began in the 1950s, escalated the number of families and livestock dependent on the pastures. Access to several traditionally used pastures was also curtailed, as those areas came under Chinese control after the war, and this further intensified the grazing pressure on the gazelle's habitat in Ladakh (Bhatnagar et al. 2006c). Additionally, eastern Ladakh has been a centre for production of high-value *pashmina* wool or cashmere, obtained from the underwool of the local *changra* goats (Jina 1999). In the last two decades, the government has been promoting *pashmina* production substantially, and that has further intensified the grazing pressure in the region (Bhatnagar et al. 2006c). Thus, our surveys suggested that while excessive hunting decimated gazelle populations throughout eastern Ladakh, intensified livestock grazing in its habitat prevented its recovery even after hunting was brought under control, and presumably precipitated further declines (Bhatnagar et al. 2006a).

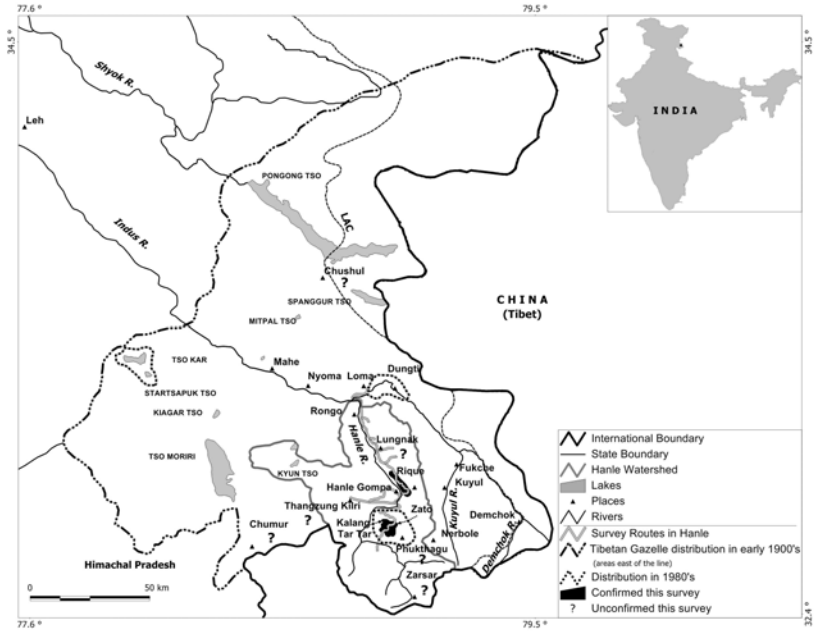
THE 'LAST SURVIVING' POPULATION

The Kalak Tartar plateau in the Hanle River basin supports the only known relatively large surviving gazelle sub-population in Ladakh. An estimated thirty individuals on the plateau, and some fragmented small populations in adjoining areas, place the total population at *c*. fifty individuals in the Hanle basin (Bhatnagar et al. 2006a). A few other small and unconfirmed populations are also reported (Bhatnagar et al. 2006a). The Kalak Tartar plateau is a small (*c*. 40 km^2) 'island' of suitable habitat with relatively low livestock grazing (due to restricted availability of drinking water for livestock), surrounded by habitats that undergo considerably high disturbance and livestock grazing. However, even on the plateau, the gazelle population has continued to decline over the past decade (Bhatnagar et al. 2006a). In 1996, Pfister (2004) had observed sixty-eight gazelles on the plateau, while Chundawat and Qureshi (1999) reported *c*. forty individuals 2 years later. A severe winter in the following year (1998-99) led to high mortality of livestock as well as wild ungulates, including the kiang *Equus kiang* (Bhatnagar and Wangchuk 2001).

The sparse forage in gazelle habitat often gets covered by snow and can become unavailable during severe winters, which can lead to starvation. Given that only *c*. thirty gazelles were recorded on Kalak Tartar in the following year in our surveys, some gazelles appear to have been lost to starvation in 1998-99, and a few others emigrated from the plateau. According to the local people, a small fragmented population of *c*. seven individuals who now survives in the Raque plains (Figure 1) got established during this period when some animals descended from the plateau. Currently, the gazelle population on the plateau faces seasonal, albeit low-intensity livestock grazing and associated disturbance in the form of the presence of herders and guard dogs. Forage scarcity during winter and threats associated with small-bodied livestock continue to be important threats to the gazelle. A population of feral dogs whose establishment and survival is facilitated by the availability of food from army camps also poses a threat to the gazelle, especially in the Raque area. Furthermore, a road to Zarser, a military outpost, traverses through the gazelle's range on the plateau and is a source of occasional disturbance. Lastly, as exemplified by rinderpest in gaur *Bos gaurus* of peninsular India

Figure 1

The current and past distribution of the Tibetan gazelle in Ladakh. Note the drastic decline in the gazelle range since the early 1900s



Source: Adapted from Bhatnagar et al 2006a.

(Karanth 1982), disease transmission from livestock remains a potential threat to the gazelle and other wild ungulates of the region. Peste des petits ruminants (PPR), which is a fatal disease, specifically affecting small ruminants, has been recently reported in the livestock of Hanle (Bhatnagar et al. 2006a).

ECOLOGY OF THE TIBETAN GAZELLE

After our initial surveys, we undertook detailed but rapid studies on the ecology of the largest and possibly the last surviving gazelle population in Ladakh on the Kalak Tartar plateau. We found that within the high altitudinal range of the gazelle (4750-5050 m) in Kalak Tartar, the species prefers relatively flat areas at mid-elevations (areas <4900 m) during both summer and winter. And, it has a greater affinity towards the warmer south-facing slopes that also have lower snow accumulation, and avoids north-facing slopes during winter (Namgail et al. 2007a). The species is partial to vegetation patches that have a higher relative proportion of forbs compared to graminoids (Namgail et al. 2007a), the former presumably forming the bulk of its diet (Schaller 1998). Sample plots in areas used by gazelles had higher overall vegetation cover than those in adjoining non-gazelle areas (Namgail et al. 2007a). The net above-ground primary productivity was also higher in areas selected by gazelles. Comparisons of fenced and control plots showed that greater plant biomass was consumed by herbivores (wild and domestic) in areas outside gazelle range (47%) than in areas inside the gazelle range (29%), thereby indicating lower grazing pressure in the gazelle range compared to adjoining areas not used by the species.

Through spatial analyses, we found that gazelles avoid areas used by domestic sheep and goats (that are relatively closer in body size to the gazelle), while they tend to co-occur with larger-bodied domestic yak *Bos grunniens* (Namgail et al. 2007a). The only significant wild ungulate population that occurs in the gazelle's range is that of the kiang, whose current density in the Hanle valley is estimated at 0.56 individuals per km^2 (Bhatnagar et al. 2006c). Although bharal *Pseudois nayaur* also occurs in the region, it is restricted to mountain slopes not used by the gazelle. In July 2004, we also sighted four sub-adult Tibetan argali *Ovis ammon* males that have presumably re-colonised the area recently, but their population is too small to have any significant impact on the gazelle.

Alongside domestic yak, the gazelle also tended to co-occur with the relatively large-bodied kiang (Namgail et al. 2007a). Thus, in terms of the forage relations between the gazelle and sympatric ungulates, there seemed to be a non-competitive relationship of the gazelle with domestic yaks and kiang, whereas its relationship with goat and sheep was competitive. The small-bodied livestock, therefore, pose a threat to the gazelle's survival. This is presumably not just due to forage competition, but also because of the disturbance caused by the herders and accompanying sheep dogs (unlike the smaller livestock, yaks are usually free ranging and not accompanied by herders or dogs).

Small populations are subject to vagaries of reproduction and natural catastrophes, and are vulnerable to extinctions due to demographic and environmental stochasticity, and behavioural (Soule 1987) and genetic constraints (Bijlsma et al. 2000). Demographic stochasticity influences how many offspring are produced, and to what extent adults can find suitable mates, while environmental stochasticity, by its effects on food supply, determines the survival and fecundity of the population. Genetic stochasticity influences the change in frequency of desirable or harmful alleles between generations. Depensatory growth and Allee effects also contribute to the vulnerability of small populations (Stephens and Sutherland 1995). All these stochastic, behavioural, and the aforementioned deterministic factors can precipitate the extinction of small populations such as that of the Tibetan gazelle. Thus, although, predictable factors such as over-hunting and habitat degradation may bring about population declines, the final extinction is often a result of smallness of a population that is unable to recover from short-term disturbances.

HUMAN ECOLOGY AND LAND USE

The indigenous people of Eastern Ladakh, known as *Changpa*, represent a tribe with a unique pastoral lifestyle in the harsh, high-altitude Trans-Himalayan landscape. Nevertheless, prior to our studies (Namgail et al. 2007b), there was no information on their social, cultural and economic status from the Hanle valley. There are *c*. 1500 human inhabitants who herd *c*. 27,000 head of livestock in the Hanle valley, translating to eighteen head of livestock per person. The human as well as livestock populations of the region increased dramatically following the influx of the Tibetan refugees that started in the late 1950s. This led to changes in the grazing system and land use in the area. Historically, the people were nomadic pastoralists, and while pastoralism continues, there is an ongoing sedentarisation process, with many families now starting to settle down in villages (with centralised amenities such as schools, dispensaries and shops), and cultivate barley (Namgail et al. 2007b). However, *pashmina* continues to remain the most important source of income in the valley and there is a major emphasis from the Government to increase its production, which has further escalated the livestock population, particularly of the *changra* goat that yields the high-value fibre. This presents a dilemma for conservation—it is this high value, small-bodied livestock that competes with the Tibetan gazelle, as established by our ecological studies (Namgail et al. 2007a).

A RECOVERY PROGRAMME FOR THE TIBETAN GAZELLE

In August 2005, a workshop was conducted with the regional wildlife department, and subsequently with representatives of the local community of the

Hanle Valley to communicate our research findings on the ecology and decline of the gazelle, and the urgent need to initiate a recovery programme (Bhatnagar et al. 2006b). It became apparent during the workshop in Hanle that the local community had been largely unaware of the decline of the gazelle throughout eastern Ladakh, which underscores the need for focused conservation education efforts in the region. Based on our research findings and discussions during these workshops, we have outlined a recovery programme for the gazelle.

Objectives of the Recovery Programme

We propose a two-pronged species recovery strategy (Figure 2) for the Tibetan gazelle based on the declining- and small-population paradigms, respectively (Caughley 1994)—consolidating the gazelle population in the Hanle Valley, and subsequently facilitating a re-colonisation of parts of its former range. Below we suggest both the short-term (5-10 years) and long-term (10-20 years) objectives for the recovery programme.

Management measures that need to be undertaken immediately in the Hanle Valley should aim to achieve the following two objectives over a 5-10-year initial period (i) ensuring the survival of the gazelle population in Kalak Tartar and arresting any further declines, and (ii) facilitating the recovery of the gazelle population in Hanle Valley to over 100 individuals so that this population could serve as a source for restocking other areas. This would require addressing all possible deterministic causes of the gazelle's decline, including forage competition with small-bodied livestock, hunting, threats due to starvation in winter, disease outbreaks, and all forms of disturbance on the Kalak Tartar plateau. Given that the Tibetan gazelle naturally occurs at densities of <1 animal per km^2 (Cai et al. 1989; Fox and Bårdsen 2005), developing a surplus population in Hanle Valley would require securing and restoring over 100 km^2 of the gazelle's habitat on the southern and eastern sides towards the border with Tibet. This would presumably also assist in making the gazelle population of Kalak Tartar contiguous with the closest sub-population on the Tibetan side to enable genetic exchange.

The objective over the longer term (*c*. 15-20 years) should be to restore the habitat and reintroduce or restock the former gazelle areas on the western side, such that the gazelle population in Ladakh increases to *c*. 400-500 individuals in several sub-populations, spread over at least 20-25 per cent of the past range of the species that was *c*. 20,000 km^2.

Management Measures

The management measures for facilitating the gazelle's recovery in Hanle Valley as well as in the former range of the gazelle in Ladakh are outlined in Table 1. Improving the habitat quality for gazelles in and around Kalak Tartar

will require removing sources of habitat degradation, reducing livestock grazing pressures, and realigning the existing road. Given that *pashmina* is an important and lucrative source of income, an overall reduction in the density of small-bodied livestock is not feasible, and instead, the focus should be on

Figure 2

A flowchart depicting the proposed two-pronged species recovery strategy for the Tibetan gazelle based on the declining- and small-population paradigms

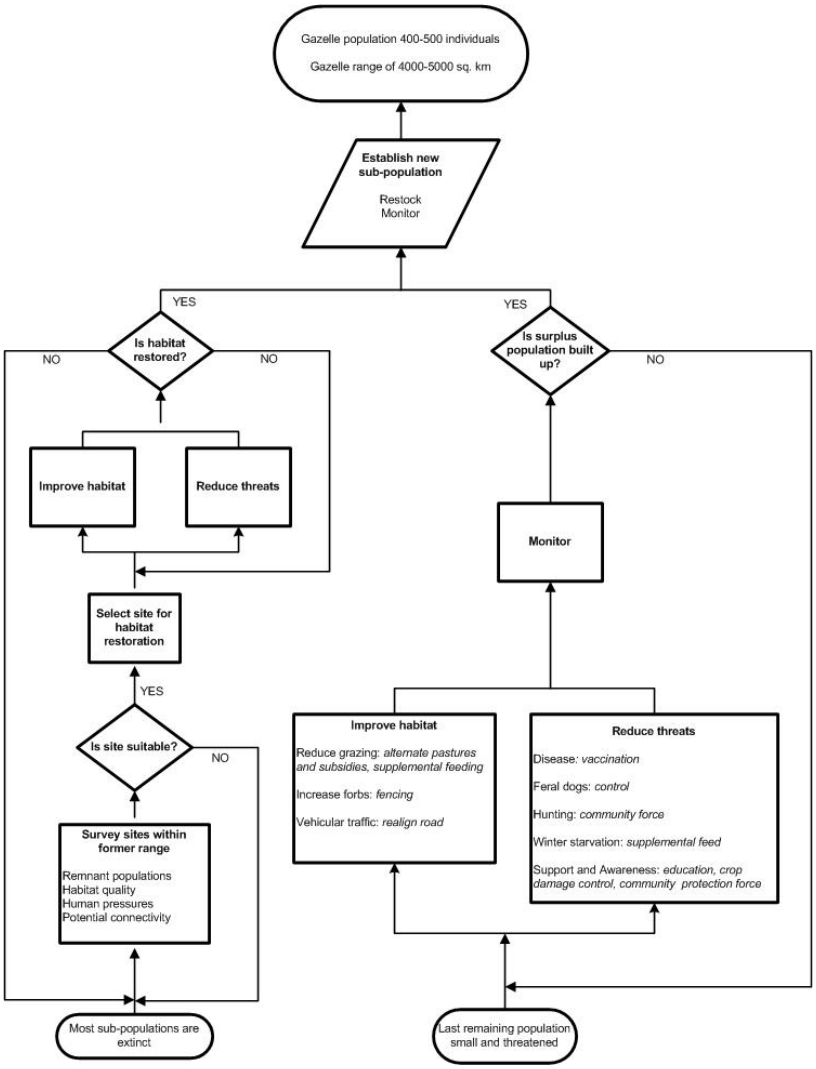


Table 1

Suggested management activities in the Hanle Valley and in the larger potential gazelle habitat in eastern Ladakh. The output, potential contribution and costs are also given

Management measures	Expected output	Potential contribution to gazelle conservation	Financial costs	Other costs
Hanle Valley				
Improve gazelle habitat				
Curtail livestock grazing by providing incentives, supplemental feed, and alternate pastures	Lowered disturbance, increased forage availability, community participation	High	High	
Increase forb biomass through seasonal low-impact fences	Increased forage availability	Moderate	Moderate	Disturbance
Realign road to Zarsar	Lowered disturbance, chances of hunting	Moderate	High	
Reduce threats to gazelle				
Livestock vaccination programmes	Lowered risk of disease, community support	High	Moderate	
Community protection force	Reduced risk of hunting, community participation	Moderate	High	
Growing and provisioning supplemental forage for gazelles	Increased forage availability, especially in winter	Moderate	High	Possibility of rejection of forage, risk of acidosis in winter
Control feral dogs	Reduced predation on gazelles	Moderate	Low	

Management measures	Expected output	Potential contribution to gazelle conservation	Financial costs	Other costs
Other activities				
Monitoring and research	Enhanced knowledge and course corrections	High	High	
Incentives to community such as protective fencing for crop-fields and other locally discussed options	Increased community support	Moderate	High	
Awareness programmes	Increased community support, sensitisation of the defence forces (army and ITBP)	Moderate	Moderate	
Eastern Ladakh				
Select sites for reintroduction/restocking				
Survey gazelle's past range for identifying remnant populations, habitat quality, human pressures, potential population connectivity	Prudent and scientific selection of sites that have maximum potential for gazelle conservation	High	High	
Habitat restoration				
Improve gazelle habitat, reduce potential threats, and undertake activities to garner community support for gazelle reintroduction	Improved habitat quality, reduced threat to gazelles upon reintroduction	High	High	
Monitoring and research	Enhanced knowledge and scientific decision making	High	High	

freeing some key areas such as Kalak Tartar from grazing by providing incentives and alternatives to the local community, including provisioning of supplementary feed for livestock (Table 1). The utility of low-impact fences in key forb-areas during summer in Kalak Tartar needs to be experimentally examined for increasing the winter availability of forbs for the gazelle. Our studies have identified that slopes of the Dokpadesa, Giagra, Zato, that are south facing (warmer and lower snow accumulation) and are exposed to wind (blowing away snow) were used more during winter and spring by the gazelles. Forb patches within these areas need to be seasonally protected. We have entered into an agreement with the pastoralists to jointly maintain an area on the Kalak Tartar free from livestock grazing for a period of at least 5 years on an experimental basis in a manner similar to our efforts in the adjoining Spiti region of Himachal Pradesh (Mishra et al. 2002). Our efforts in the Kibber pastures of Spiti have led to a village-managed livestock-free reserve of 15 km^2 that has seen a considerable recovery of the bharal population. Additionally, realigning the road that presently passes through prime gazelle habitat will remove an important source of disturbance to the gazelles. We have noted gazelles taking to flight on seeing a vehicle approaching from over a kilometre away.

In addition to habitat improvement, several potential threats to the gazelle population in Kalak Tartar need to be addressed. Removal of feral dogs and complete vaccination of local livestock will immediately address two of the important threats. Establishment of a small protection force with members drawn from the local community will go a long way in securing community support for conservation of the gazelle. The protection force will deter hunting, as well as assist in monitoring and research.

Supplemental feeding of gazelles in winter is one of the options for removing the risk of starvation-related mortality. However, gazelles and small antelopes have been reported to often reject provisioned fodder (Raman et al. 1996). The Tibetan gazelle in Kalak Tartar rejected most of the *c*. 8 tons of alfalfa provisioned by the local wildlife department during the winter of 2004-05. At the same time, high-quality green forage, if accepted by gazelles during winter when most of the available forage is relatively low quality, can potentially cause rumen acidosis and lead to mortality (Owens et al. 1998). Small-scale experimentation may be undertaken with the local communities in growing locally occurring species such as *Oxytropis* spp. and *Saussurea* spp. in farms and supplying to gazelle areas in winter. Supplemental feeding of gazelles if undertaken will need to be done with utmost prudence.

Other activities that need to be initiated in the Hanle valley include a sustained awareness programme for the local community as well as the army. The support of the local community for the species recovery programme may also be sought by assisting them in other ways, such as protective fencing for their crop fields to reduce crop depredation by the kiang. Continued research and monitoring will be critical to constantly evaluate the status of the gazelle,

and to assess the success of the species recovery programme. When the gazelle population in Kalak Tartar and surrounding areas exceeds 100 individuals, the surplus population may be used for reintroduction and restocking its former range.

An important step to be undertaken simultaneously is to clearly identify all areas where gazelle were known to occur in the past or where small populations may still persist. Potential areas include Tso Kar, Chushul, Chumur, upper Kuyul and some other sites within the Hanle valley such as Thagzung Kilri, Zarsar and the upper plateau at the junction of the Zarsar and Kuyul watersheds (Bhatnagar et al. 2006b). The extant threats to gazelles or their habitat in these sites will need to be understood, and their suitability for restoration assessed based on the occurrence of any remnant gazelles, habitat quality, human pressures, and potential for connectivity with other gazelle sub-populations (Figure 2). After identification of suitable sites, habitat restoration, addressing potential threats to the gazelles, and garnering local support for gazelle reintroduction will need to be undertaken. Constant monitoring and research will assist in assessing the suitability of each site for reintroduction or restocking, as shown in the Figure 2.

The approach outlined in this article also has applicability for numerous other endangered species of the region such as the Tibetan argali and Ladakh urial. There is an urgent need to identify existing areas in the Trans-Himalaya with relatively large populations of endangered species and conserve them with the support of local communities and civil society organisations. Large protected areas are desirable, but given the human use pressures and the widespread wildlife in the region, such PAs are mostly not feasible (PSL 2006). We have been working with the five Himalayan state governments and the Ministry of Environment and Forests to promote such a conservation approach in the higher Himalaya and Trans-Himalaya under a national programme called Project Snow Leopard, which is expected to be operationalised shortly (PSL 2006).

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