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Modern wildlife conservation initiatives and the pastoralist/hunter nomads of northwestern Tibet

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Abstract: In 1993 the Tibet Autonomous Region (TAR) of China established the 300 000 km² Chang Tang Nature Preserve on the northwestern Tibetan plateau, an action precipitated by rapidly diminishing populations of chiru (Tibetan antelope) and wild yak. Some 30 000 nomadic pastoralists use areas within this reserve for livestock grazing, with many having traditionally depended in part on hunting for supplementary subsistence and trade. Following a 1997 request from TAR leaders for international assistance in addressing the conservation issues associated with the creation of this reserve, the TAR Forestry Bureau and the Network for University Co-operation Tibet – Norway began a 3-year research collaboration program in 2000 to outline human-wildlife interactions and conservation priorities in the western part of the reserve. To date, four excursions (2-6 weeks each) have been made to the western Chang Tang region, and investigations of interactions between pastoralists and wildlife conservation objectives have been initiated in an area of about 5000 km², including the 2300 km² Aru basin located at 5000 m elevation at the northern edge of pastoralist inhabitation. The Aru site is unique in that nomads have only recently returned to this previously off-limits basin. But, as in surrounding areas, the people's lives are undergoing changes recently influenced by the introduction of permanent winter houses, changing international trade in shahtoosh and cashmere wool, and a move towards stricter hunting regulations. The northwestern Chang Tang, with the Aru basin as a prime site, represents one of the last strongholds of the endangered chiru and wild yak, as well as home to Tibetan gazelle, kiang, Tibetan argali, blue sheep, wolf, snow leopard and brown bear. In autumn 2000, for example, with approximately 12 000 of the wild ungulates (mostly the migratory chiru) within the Aru basin along with some 8000 domestic livestock, issues of land use overlap and possible grazing competition are clear to both local nomads and reserve managers. Whereas livestock development actions elsewhere on the Tibetan plateau are promoting increased livestock production, they are doing so at the expense of wildlife, and such an approach will not be appropriate in areas where wildlife conservation is a major priority. Although some of the ongoing livestock development programs may be adapted to the western TAR, new approaches to pastoral development will have to be developed in the reserve. The ultimate goal of enhancing the nomads' standard of living, while conserving this truly unique array of biodiversity, presents a daunting challenge.

Key words: Chang Tang Nature Preserve, chiru, conservation and development, wild yak.

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Introduction

In conjunction with a late 1997 visit to Europe by leaders of the Tibet Autonomous Region (TAR), China, interest was expressed in receiving international assistance in addressing conservation issues associated with the creation of a large nature reserve in nomadic pastoral areas of the northwestern Tibetan plateau. The TAR had recently established the second largest protected area in the world, the 300 000 km² Chang Tang Nature Preserve, and was interested in assistance in the development of suitable management initiatives. In response to this request, in 1998 the two senior authors visited Tibet to make initial contacts with appropriate authorities, and in the spring of 1999 both accompanied TAR Forestry Bureau and other

government officials on a reconnaissance survey traversing over 800 km across the central portion of the reserve. In the spring of 2000 the TAR Forestry Bureau (TARFB) and the University of Tromsø, under the auspices of the Network for University Co-operation Tibet – Norway, signed a 3-year research collaboration program designed to study human-wildlife interactions and their conservation consequences in the western part of the nature reserve. Field research was initiated in summer of 2000 with a month-long excursion to the site selected for intensive study, the remote Aru basin (Fig. 1), and has continued with 6-week excursions to the area in autumn of 2000 and 2002, and early summer of 2001. In addition to TARFB participation, the fieldwork has been conducted in co-operation with the Tibet Academy of Social Sciences, the Biology Department of Tibet University, and the Tibet Agriculture and Animal Husbandry College.

Chang Tang Nature Preserve

The Chang Tang Nature Preserve was established in 1993. This action, brought about by recent reductions in populations of chiru or Tibetan antelope (*Pantholops hodgsoni*) and wild yak (*Bos grunniens*) (Fig. 2) throughout their ranges on the plateau, reflects a growing commitment by the TAR to conservation of its natural resources. The TAR's initial request for assistance noted that "... wildlife have high economical values, in order to prohibit catching and killing, preserve ecological balance, it is imperatively important to set up a wildlife nature reserve". At the time, chiru populations were being decimated over much of the Tibetan plateau, precipitated by a spectacular jump in pelt prices to supply an increasing international market for "shahtoosh" garments woven from the chiru's fine wool (Kumar & Wright, 1998; Schaller, 1998). Although much of the chiru's slaughter has been carried out by organised poachers, smaller-scale but increased hunting and trapping by nomads has exacerbated the species' decline. In fact, many nomad families in what is now the reserve probably substantially increased their cash flows in the early 1990's as chiru pelt prices rose (Næss *et al.,* 2004), and many were able to purchase trucks or other vehicles for the first time (Fig. 3).

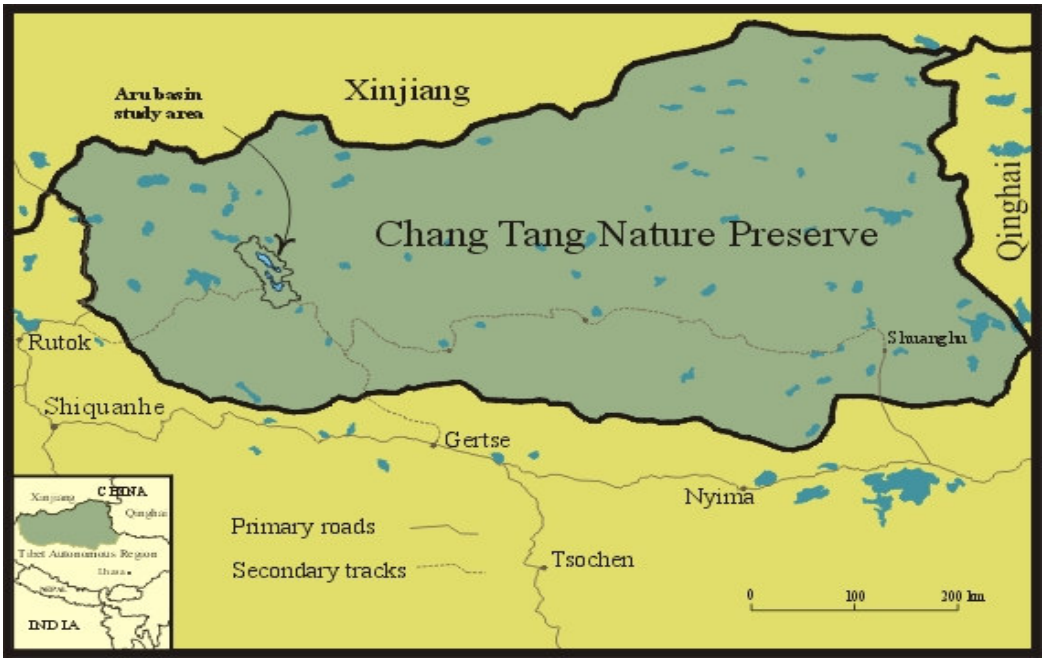

Fig. 1. The Chang Tang Nature Preserve, showing the location of the primary study area within the catchments of Aru and Memar lakes, the major travel routes to the basin, and the routes of our cross-reserve traverses.

Fig. 2. Chiru (Tibetan antelope) and wild yak in the Aru basin.

Some 30 000 nomadic pastoralists depend on rangelands within the reserve for livestock grazing, and those in areas with significant wildlife density have traditionally depended in part on hunting for supplementary subsistence and trade (in part for shahtoosh). With rapid changes in wildlife markets, government subsidised modernisation of pastoralism, and concerns over preserving Tibet's wildlife populations, the establishment of the nature preserve has brought into sharp focus conflicting aspects of these various factors. The TAR's 1997 request for assistance focussed on development aid associated with the creation of the reserve; our project aims to provide baseline information upon which management of wildlife and livestock can be developed to ensure the continued presence of threatened wildlife as well as a better standard of living for nomads in the reserve.

The northwestern TAR is one of the least productive and poorest parts of the region. At an average elevation of over 4500 m it is too high to support any cropping, and nomadic pastoralism remains the primary livelihood for most residents. Whereas other parts of the Tibetan plateau in the TAR and Qinghai Province have seen significant livestock and community development activity, the northwest has yet to see much, and officials are admittedly looking to financial advantages associated with nature preserve designation as one means to improve nomads' livelihoods.

In Qinghai Province, for example, programs in pastureland privatisation and a concomitant livestock "ranching" approach to management are changing the scope of pastoralism by decreasing mobility while trying to stabilise livestock numbers. Although livestock productivity and overall density may be increasing in some areas, the distribution among families is skewed (and becoming more so) (van Wageningen & Sa, 2001), and the long-term development advantages of some changes are debatable (Goldstein, 1996; Miller, 1998). But unlike the traditional pastoralism that co-existed with abundant populations of large wild herbivores, these development actions have the potential to fully utilise the productivity of the rangeland, and exclude wildlife. In its retention of the traditional, common ownership of pasture land, the Tibet Autonomous Region (TAR) has taken a somewhat different approach to livestock development, although similar investments to increase livestock productivity are also being introduced and are likely to greatly alter the scope of pastoralism in the TAR. The Chang Tang Nature Preserve represents the first instance of a large-scale effort to combine wildlife protection with pastoral development in western China, and the application of development initiatives currently promoted elsewhere on the plateau will require objective re-evaluation in relation to wildlife conservation goals.

In any case, the effects of development actions on the plateau should be evaluated within the context of this unique high elevation rangeland ecosystem. One of the most dramatic aspects of traditional pastoralism on the Tibetan plateau is the potentially devastating effect of snowstorms on the survival of livestock. Large-scale losses are rare, but they do happen, for example during the winter of 1997-1998 over 3 million head of livestock were lost due to heavy snowfalls in the TAR alone (Miller, 1998). Less widespread losses are a normal fact of life for the nomads, and their strategy under such conditions is to constantly attempt to increase livestock numbers; the more livestock the herder has, the easier it will be to recover from the density-independent snow-caused losses. Some observers of pastoralism in Tibet (Miller, 1998, in press; Goldstein, 1996) have noted that the ecosystem, at least in the relatively dry western portion, resembles

Fig. 3. Nomad camp in the Aru basin, with a recently purchased truck used for moving camp and transportating wool to market.

the non-equilibrium system of the dry Sahel region of Africa where nomadic pastoralists face periodic drought-induced livestock die-offs (Ellis & Swift, 1988). In such a system, annual vegetation productivity is highly variable and grazing density-dependent effects are not apparent. In Tibet, "the recurrent episodes of livestock decimation appear to have been frequent enough to create a stable, non-equilibrium system in which grasslands were not systematically destroyed despite continuous utilisation for at least one, perhaps two or more, millennia" (Goldstein, 1996). Others suggest that the Tibetan plateau rangelands do resemble an equilibrium ecosystem in that a fairly predictable annual monsoon-driven vegetation production occurs (Schaller, 1998), and vegetation productivity and composition can be more influenced by grazing. It is, then, rather the unpredictable snow events (possible at any season) that cause significant localised livestock mortality and bring a dis-equilibrium to the pastoral system. In either case, however, the rational herder strategy remains one of continuous increases in livestock numbers. But, if snow-determined forage availability is the major environmental factor, then unlike the similarly unpredictable drought-affected pastoral systems where fundamental forage production is greatly affected, in Tibet the forage is there (and often enhanced by the moisture brought in the form of snow) and in-situ recovery potential for livestock is high once the snow disappears. Such a significant factor in pasture management needs to be better incorporated into pasture productivity and carrying capacity modeling for the Tibetan plateau, for example as is being attempted with other snow-affected ungulate ecosystems (Hobbs *et al.*, 2002; Wang *et al.*, 2002). Reassessments of pastoral ecosystem function are being attempted from sociological and organisational perspectives (Roe *et al.,* 1998), but an ecological evaluation of the snow-affected ecosystems is overdue.

The environmental conditions on the Tibetan plateau have several consequences for livestock development that are different from the drought-dominated non-equilibrium situation. The primary difference is that with interventions to successfully reduce livestock mortality associated with extreme cold and snowfall events, the herder should be able to maintain a higher and more stable or predictable livestock population. Such a situation could then permit pastoralists to more closely approach the forage carrying capacity of the rangeland, and can conceivably bring about relatively easily gained "productivity" advances in livestock development. The downside is that overuse of forage resources, a virtually inconceivable situation under traditional pastoralism in western Tibet, may be reached without careful evaluation of carrying capacity. Assuming such a scenerio, it is not difficult to envision that over the past millennia or two in the traditional pastoral system the frequent episodes of snowfall-induced livestock mortality kept pastoralist livestock density well below forage carrying capacity and allowed a coexistence with abundant wild herbivores. Although the wild herbivores were also undoubtedly affected by severe snow storms, if they are able to better deal with or recover from such environmental conditions, then the available forage could support their substantial populations in addition to livestock. Therefore, the recent elimination of large wild herbivores with efficient modern weapons over much of the Tibetan plateau

(Schaller, 1998), and the widespread poisoning of small herbivores (Fan *et al.*, 1999) arguably leaves more of the forage productivity available to any increases in livestock density. This may be fairly straightforward with regard to the large ungulate herbivores, but as the small fossorial herbivores (*e.g.*, pikas) may also influence soil quality and consequently forage characteristics, the effects of their removal on long-term productivity of the rangeland is still unknown (Smith & Foggin, 1999; Holzner & Kriechbaum, 2001). From the development point of view, easily obtained increases in livestock density (over traditional levels) may be seen over the short term, but continued increases in livestock density are likely to quickly overstep the limits of the pastures. In any case, livestock development actions made under the above assumptions leave essentially no room for conservation of wild herbivores, and their direct application to conservation areas where natural biodiversity is highly valued is not appropriate.

Biodiversity values

Unlike in much of the rest of the Tibetan plateau, where wildlife populations are much reduced from levels of a century ago, in parts of the northwestern Chang Tang wildlife numbers have probably not greatly changed or are only beginning to decrease. Due in part to its low overall productivity and its remoteness (*i.e.*, little human exploitation), the northwestern Tibetan plateau today constitutes one of the best remaining examples of extant flora and fauna, especially that of large mammals, in central Asia. In fact, the relatively undisturbed large wild herbivore populations and their predators represent one of only a few such remaining assemblages on earth, prompting the renowned field biologist George Schaller to refer to it as a "high-altitude Serengeti" (Grosvenor, 1986). Although in the past wildlife densities were probably higher elsewhere in the more productive areas of Tibet, the best wildlife areas remaining today are also the least productive simply because they are also the most remote. Large populations of migratory chiru, and other large herbivores such as wild yak, Tibetan gazelle (*Procapra picticaudata*), Tibetan argali sheep (*Ovis ammon*), blue sheep (*Pseudois nayaur*), and Tibetan wild ass (*Equus kiang*) still roam much of the high plains and mountains of northwest Tibet, along with their predators that include wolf (*Canis lupus*), snow leopard (*Uncia uncia*), brown bear (*Ursus arctos*) and lynx (*Lynx lynx*). Besides the larger herbivores and their predators, other species include the Tibetan woolly hare (*Lepus oiostolus*), Himalayan marmot (*Marmota himalayana*), black-lipped pika (*Ochotona curzoniae*) and small rodents. Smaller predators include Tibetan sand fox (*Vulpes ferrilata*), red fox (*Vulpes vulpes*), steppe polecat (*Mustela eversmanni*), and possibly the manul or Pallas's cat (*Felis manul*). The resident bird fauna is not numerous (Zheng *et al.*, 1983; Schaller, 1998), but several of the larger species include the Lammergeyer (*Gypaetus barbatus*), Himalayan griffon (*Gyps himalayanus*), upland hawk (*Buteo hemilasius*), saker falcon (*Falco tinnunculus*), Tibetan snowcock (*Tetraogallus tibetanus*) and Tibetan sandgrouse (*Syrrhaptes tibetanus*). The bar-headed goose (*Anser indicus*) and ruddy sheldrake (*Tadorna ferruginea*) as well as other migratory species are summer breeders on the high lakes or steppe, and a number of other long-distance migrants (*e.g.*, little gull, gadwall) apparently use the lakes and marshes as rest stops during spring or autumn. There are no amphibians and only one reptile present, a lizard (*Phrynocephalus theobaldi*). Whereas many of the large mammal species have been greatly reduced in number on other parts of the Tibetan plateau, the Chang Tang reserve presents a unique opportunity to protect the last remaining widespread populations of several of these species.

As one can imagine, however, this wealth of wildlife abundance represents something of an implied paradox for development of the nomadic pastoralist populations that make a livelihood there. On the one hand, where wildlife is still abundant, the nomads, as they have traditionally done, depend on some hunting for sustenance and sources of trading commodities. This is especially true near the northern limits of human habitation in the Chang Tang; the core areas and their vicinity in the reserve. On the other hand, where increases in livestock productivity are demanded by human population increases and modernisation, the presence of significant numbers of potentially competing herbivores and predators that kill livestock is anathema to the herders. Once abundant large wild herbivores have been eliminated or greatly reduced from most of the Tibetan plateau (Goldstein, 1996; Schaller, 1998); current pasture improvement and livestock development programs will probably preclude their return. How then does one promote improvements in pastoralist livelihoods while at the same time ensure wildlife conservation. Or, as has been argued in parts of Africa, are these mutually exclusive alternatives (see Prins, 1992).

Aru basin study site

The Aru basin is an approximately 2300 km² fully enclosed catchment (no outlet), situated at about 5000 m elevation near the northern limit of pastoralism (Fig. 1), and is included within part of the original core area designation of the Chang Tang Nature Preserve (TARFB, 1998). It has been described as one of the best areas for wildlife in the entire reserve (Schaller & Gu, 1994), and efforts to minimise human impacts on wildlife are considered to be a high priority (TARFB, 1998). It encompasses unparalleled biodiversity values that characterise the rationale for the reserve's creation, and thus represents one of the key areas for wildlife conservation within the entire 300 000 km² area. Abundant forage on the *Stipa*-forb vegetated alluvial fans and alpine hills on the eastern slopes of the Aru mountains make for relatively rich grazing lands compared with elsewhere in the northwest Chang Tang, and the abundance of both wildlife and sought-after grazing areas for livestock is not surprising (Fig. 4). Farther from the mountains, the drier and less productive *Stipa* and *Ceratoides-Carex* steppe typical of most of the northern Chang Tang predominates. The Aru basin's only significant drawback as livestock grazing areas is that at this elevation the relatively frequent mountain-induced snowfalls near the Aru range (even in summer) often reduce the availability of forage.

The Aru basin site is also unique in that nomads have only recently returned; it having been off-limits for some 15 years in efforts to keep pastoralists closer to administrative centers. The abundance of wildlife may also be a consequence of that rest from potential competitors for forage and from hunters. The basin is situated within a larger region of more moderate wildlife abundance, with ongoing administrative and livestock development activities that recognise a higher priority for pastoral development, while within the context of the nature reserve still trying to minimize negative impacts on wildlife.

Pastoralists

The nomads throughout the area are currently undergoing a modernising of livelihoods affected by the introduction of permanent winter houses (altering seasonal migration patterns), development of local community administrative centers, vehicular transportation, changing international trade in shahtoosh and cashmere and a move towards stricter wildlife conservation laws (Næss *et al.*, 2004). As Schaller & Gu (1994) have noted, "in 1991, 5 families (~40 people) moved their 600 sheep and goats and 45 yaks into the [Aru] basin permanently, primarily to hunt wildlife". This was in addition to about 21 families with about 8600 livestock that used the basin on a seasonal basis at that time (Schaller & Gu, 1994). In 2000, there were about 19 permanently resident families within the Aru basin, and another 30 families that used it part

Fig. 4. Nomad women milking goats at 5000 m elevation in the Aru basin. Chiru and gazelle are common and kiang occasional on the plains in the foreground, whereas wild yak, blue sheep, snow leopard and brown bear are found in the lower parts of the mountains.

of the year for livestock grazing. In the summer of 2000 there were about 230 people and 15 000 livestock using the Aru basin for grazing, whereas during autumn of the same year there were about 105 people and 8000 livestock (Næss *et al*., 2004). Nomads moved their camps often, and during all seasons were affected by occasional snowfalls that influenced their movement decisions and timing, especially for those nomads with much of their grazing areas abutting the eastern slopes of the Aru mountains. With 20 permanent winter houses currently in the basin, the amount of settlement and grazing use we observed contrasts sharply with the only 5 year-round families and no permanent houses reported from 1991 (Schaller, 1998); indicating a substantial increase in human use within the basin over the past decade.

The nomads today are aware of competitive pressures on good grazing land, and in view of the current ban on hunting, a good livelihood is even harder to maintain than it was just 5 years ago, when hunting was still a legal option. The herders complain of an increase in abundance of an unpalatable, and apparently sometimes poisonous, legume (*Oxytropis* sp.); a situation that could be due to increasing levels of grazing in the basin. In June of 2001, 3 of the 19 families permanently resident in the Aru basin decided to move their permanent base to the west of the Aru basin, due to the difficult environment and perceived decreasing quality of grazing conditions in the basin. It is clear that the nomads are experiencing uncertainties regarding their future that relate to both grazing and hunting, and thus affecting their strategic thinking in determining the best alternatives for improving livelihoods for themselves on the high pastures.

Wild ungulate populations

Based on surveys conducted during 2000-2002, the chiru population in the Aru basin varied from about 1500 males (and a few barren females) in summer to over 11 000 individuals of both sexes (including newborns) in autumn of 2000 (Fox *et al*., in review). The summer numbers are similar but the autumn count is much higher than reports from the early 1990's (Schaller & Gu, 1994), and probably reflects the variable migratory behaviour of this species, with large numbers wintering within the basin in 2000-2001 and 2002-2003, whereas they had wintered farther south in 1990-1992. There are currently about 250 Tibetan gazelle, 150 Tibetan wild ass and 350 blue sheep resident in the basin (Fox *et al*., in review), and these numbers do not appear to have changed substantially from those documented in the early 1990's (Schaller & Gu, 1994). The situation for wild yak, however, is quite different, with summer numbers declining from over 680 in 1990, to about 350 in 1992 when pastoralists had fully occupied the basin (Schaller & Gu, 1994), to less than 200 observed during 2000-2002 (Fox *et al*., in review). Whereas hunting has probably contributed to the decrease in wild yaks, current levels of livestock grazing may also be detrimental to wild yak survival, an interaction that needs to be better assessed.

For ungulates other than wild yak, livestock use does not appear to have had a significant effect on populations to date. Regarding chiru, hunting has not as yet decimated numbers this far west; the Aru basin appears to represent an important part of the migratory range of the still largely intact Western Chang Tang herd. In any case, with some 8000 livestock and close to 12 000 chiru and other wild ungulates using the Aru basin in some winters, forage resources may be approaching a limiting level at least in some parts of the basin (perhaps illustrated by increases in unpalatable forage species). An assessment of forage productivity and estimation of sustainable livestock and wild herbivore stocking rates is greatly needed, and is a future objective of the project.

Nomads and wildlife

The resident nomads indicate that life in the Aru basin is hard; far from modern amenities and subject to unpredictable environmentally-related factors that pose many challenges to successful livestock husbandry. They do live at the northern edge of human presence in the Chang Tang, thus contending with a region of low productivity which is clearly marginal for human subsistence. They believe that the large numbers of wild ungulates present in the basin consume substantial amounts of forage, especially in the areas the nomads are saving for the winter grazing of their livestock. Furthermore, the nomads consider the wolf to be a major problem, with their livestock suffering from frequent night-time attacks, and the only protection afforded is the presence of dogs to scare off predators. Brown bears and snow leopards are lesser threats to livestock, but the bears can wreck a tent camp or the new houses where supplies are stored, and be quite dangerous to humans if surprised. Male wild yaks can greatly disrupt the domestic yak herds, especially during mating

season, and are thus greatly disliked by the nomads. South of the Aru basin, kiang are numerous in some areas and constitute a competitive grazing menace according to some of the nomads. Pikas, abundant on some of the pastures, are subject to eradication programs elsewhere on the plateau.

Hunting of chiru, wild yak and other large herbivore species has been an important traditional nomad activity in the Chang Tang, an activity carried down from the first nomadic hunter inhabitants of the region over 20 000 years ago (Brantingham *et al.*, 2001). Today, hunting is no longer an option in the many areas of the Tibetan plateau where large wild herbivores have been eliminated, but in those areas where some wildlife remains, *e.g.*, for the Phala nomads on the south-central plateau, hunting is still considered a secondary option (Goldstein & Beall, 1990; Goldstein *et al.*, 1990). In the northwestern Chang Tang, hunting has been an important livelihood component for some nomads until recently and, as indicated earlier, was a major reason for the return of nomads to the Aru basin in the late 1980's. Although the nomads in the Aru basin report formally that they ceased hunting in the mid-1990's, once the government's 1993 prohibition began to be enforced, it is clear that some local hunting continues here as well as elsewhere in the reserve. Before the hunting ban, chiru were especially sought after because the nomads could get both meat from the animals and good prices for the pelts (later traded to India for "shahtoosh" weaving). Many of the Aru nomads have in recent years been caught and fined for illegal possession or sale of chiru pelts, and there is thus currently a clear conflict of interest between wildlife conservation and local community interests in the basin (Fig. 5). As a consequence, following the prohibition of hunting, the nomads feel their life situation has become worse, forced to rely totally on the uncertainties of livestock husbandry under marginal pasture conditions. Now, if they lose too many animals due to snowstorms and wolves, they are concerned that they no longer have the hunting option, with its provision of both meat and income.

Wildlife conservation and nomadic pastoralism in the northwestern Chang Tang

Although organised poaching of chiru is currently a major problem elsewhere, it has not yet become so in and around the Aru basin. Nevertheless, the decreasing chiru population throughout its distribution has made the few remaining chiru strongholds, such as the Aru basin and vicinity, critical to chiru conservation. The nomads around the Aru basin do not appreciate this conservation imperative and feel discriminated against because the chiru are still abundant in their midst. Very limited subsistence hunting could be a management option here, although the problems with controlling corollary hunting could be overwhelming. On the other hand, although wild yak are still present in the Aru basin, their current number of about 100 represents a 75% reduction in the decade since people returned, and the wild yak's apparent susceptibility to human disturbance needs to be seriously addressed in conservation zones designed for their protection.

Fig. 5. Confiscation of antelope traps from a nomad (left) and chiru pelts and horns confiscated from traders (right) who bought them from nomads, both just SE of the Aru basin.

In terms of the larger development picture, where wildlife conservation is a major goal, the widespread and popular pastoral development programs to increase livestock productivity are not compatible with maintaining populations of wild ungulates and other herbivores (Fox, 1997). Simply put, in areas set aside for large ungulate conservation, livestock densities cannot be as high, relative to carrying capacity, as in areas where domestic animal production is the primary goal. Increases in the human population that depend on pastoralism will not be possible either, and certainly not to the extent seen recently in the Aru basin.

What development actions then, are appropriate where wildlife conservation is a major goal? Clearly, as a start, better basic education and health facilities are needed in the areas designated for pastoral development priority, and a commitment to reserve management, including education and hire of locals as staff, can contribute to an enhancement of living standards. Regarding livestock development, with careful application of some of the initiatives being undertaken elsewhere in Tibet and Qinghai, nomads in the Chang Tang Nature Preserve can probably achieve substantial benefit from the increased and more stable livestock survival brought about by improved overnight holding pens and better veterinary care, but numbers will have to be limited. Some fencing of winter pasture in non-core areas of the reserve may be appropriate, but any large-scale fencing programs will probably be detrimental to the migratory chiru, and wild yak. In this sense, maintaining the mobility of pastoralism, in contrast to moves towards sedentarisation elsewhere on the plateau, may be an important means to insure compatibility between wildlife and nomads in the reserve. The rodent and pika poisoning prevalent on other parts of the plateau will also not be appropriate in the Chang Tang Nature Preserve, especially given the apparent ecological importance of the pika in maintaining biodiversity (Smith & Foggin, 1999).

Eco-tourism in the Chang Tang could probably offset some of the livelihood loss due to restrictions on livestock numbers, but a substantial infrastructure in the form of roads and lodging is required before that potential can be exploited. In the meantime, such tourism will not develop significantly unless the large populations of ungulates, a primary attraction, are maintained. Regardless, it should be clear to planners that the Chang Tang will never achieve visitation rates approaching those in spectacularly scenic areas such as Qomolongma.

The currently designated Chang Tang Nature Preserve, at 300 000 km^2, is an immense area to be devoted to nature conservation. Clearly, a careful designation of core areas is required wherein natural biodiversity protection is the highest management priority, with substantial portions of the reserve designated to accommodate human livelihood enhancement as a major priority. And as indicated above, uncritical application of development actions underway elsewhere on the plateau will not be sufficient to the attainment of this goal, and alternatives need to be researched. The choice of appropriate livestock development initiatives will be critical to maintaining a workable balance between pastoralism and wildlife conservation.

In any event, if the reserve is to be successful, wildlife conservation measures designed to include recognition of the livelihood and development requirements of the local nomads are required urgently. In essence, the nomads have had to constantly re-evaluate their overall strategies in recent decades, in response to new outside-initiated livestock development and nature conservation initiatives with which they are conceptually not familiar. Hunting bans, and other restrictions without proper explanation and compensatory action will only antagonise the reserve's residents. We suggest that conservation initiatives should plan high priority in efforts to: a) prevent organized outside poaching; b) address the decreased nomad standard of living brought on by the current hunting ban; c) control livestock depredation by wolf; d) improve livestock survival in severe conditions and improve monetary return per cashmere goat; e) maintain sufficient grazing access for the wild ungulates that use the Aru basin on a seasonal or year-round basis, including limiting disturbance to the remaining wild yaks; and f) evaluate where limits to livestock use within the basin might be placed. The first two items demand immediate law enforcement and development aid programs, respectively. The second two items can be addressed with some of the programs used elsewhere, such as improved livestock shelters and veterinary care. The last two will require additional research to address issues of pasture productivity and allocation, and a close co-ordination between such research and the design of management actions. Lastly, improved education for residents of the reserve, from basic education to training appropriate for hire as reserve staff, will probably serve to enhance all aspects of a conservation program. Protection of the Chang Tang's environment lies in the balance, and we hope to see

initiation of some of the above actions in the near future.

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