Bear-proof fences reduce livestock losses in the Tibetan Autonomous Region, China

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SUMMARY

Tibetan brown bears *Ursus arctos pruinosus* in the Tibetan Plateau attack and kill livestock and ransack homes for food, causing significant economic costs for local herders. Although a government fund compensates herders for livestock lost to bear attacks in the Tibetan Autonomous Region (China), compensation may not reflect the real cost of losing livestock and payments can be delayed. We investigate whether bear-proof fences are a cost-effective method for reducing bear attacks and livestock losses. In January 2009, 14 bear-proof fences were constructed from wire mesh and steel posts around households which had previously experienced substantial losses to bear attacks in the Nagqu Prefecture of the Tibetan Autonomous Region. These households lost 162 animals to bears in the year before fence construction, whereas just three animals were lost in the year after fence construction. Fences were still standing 4.8 years after completion and any small damage has been repaired by households. For households that suffer substantial losses to bear attacks, bear-proof fences appear to be an effective and cost-saving intervention to reduce human-bear conflict.

BACKGROUND

Tibetan brown bears *Ursus arctos pruinosus* are endemic to the Tibetan Plateau. They are listed as a protected species in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora and are a second-class key protected species in China, signifying special State protection and management, and prohibition against killing individuals (Harris 2008). Although plateau pika *Ochotona curzoniae* reportedly form most of their diet (Xu *et al.* 2006), Tibetan brown bears also attack small livestock, such as sheep and goats, and raid human households for food (Worthy & Foggin 2008). Households in the Tibetan Autonomous Region near the Changtang National Nature Reserve also experience conflict with snow leopards, wolves, foxes and lynx, but Tibetan brown bears are responsible for substantial livestock losses, food raids and household damage (Tsering & Farrington 2008). A government compensation scheme for personal injury and property damage by bears was announced in 2006 to reduce the cost of this conflict for local herders. However, there was concern that this scheme did not address the underlying cause of the damage, and was placing a large financial burden on the Tibetan Autonomous Region government. In the first two years of the program, annual compensation paid for damage by bears in Nyima county alone was USD 66,700 (Lu *et al*. 2012). In 2008, the Wildlife Conservation Society, World Wide Fund for Nature, Tibetan Autonomous Region Forestry Bureau and Nagqu Forestry Bureau started a project to evaluate the effectiveness of bear-proof fences in preventing and mitigating human-bear conflicts. This study aimed to evaluate whether bear-proof fences would reduce livestock losses and also compensation costs.

ACTION

Fourteen bear-proof fences were constructed in the towns of Baling and Nyima in Tibetan Autonomous Region near Changtang National Nature Reserve (Figure 1). As some fences encircled more than one household, a total of 20 households participated in the study, each one recording the number of bear visits, bear attacks and number of livestock lost from January 2008 to December 2009. One household in Baling dropped out of the study, so the data presented correspond to 19 households inside 14 fences. The number of sheep and goats kept within the fences ranged between 120 and 1,000 animals over the duration of the study.

Figure 1. The location of the Tibetan Autonomous Region (TAR) within China, showing the location of Changtang National Nature Reserve and Nyima and Baling towns within Nagqu Prefecture (zoomed area).

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Table 1. Materials needed for the construction of bear-proof fences used in this study. Recommendations for possible modifications to this design are presented in the consequences.

Fence part	Material	Dimensions	Additional information
Fencing	SWG10 iron wire	2 m high	Fishing net mesh weaved from wire, mesh diagonal no bigger than 30 cm
Corner and door posts	Angle steel	2.5 m high, 9 x 9 cm wide	70 cm buried in ground, 1.8 m above ground
Side posts	Angle steel	2.5 m high, 4 x 4 cm wide	70 cm buried in ground, 1.8 m above ground, every 5 m
Door	SWG 10 iron wire Angle steel	Door: 2 m high, 1.8 m wide Angle steel: 4 x 4 cm wide	Mesh weaved from wire, mesh diagonal no bigger than 30 cm. Strengthened with two parallel vertical steel angles
Support bars	Steel pipe	3 m long, tubular shape	Two at each corner and one on each door post
Barbed wire	SWG 12 iron wire		Four strands vertically separated by 15 cm, fixed by thin iron wire every 50 cm
Barbed wire support	Angled steel	50 cm long, 4 x 4 cm wide	Folded at 20 cm to form an angle of 150º, attached to top of side posts
Fastening	SWG 12 iron wire	As much as needed	Used for fastening barbed wire, fencing and all other parts to posts

Households were selected for participation if they had previously suffered substantial livestock losses to wildlife, were close to access roads and had basic literacy to allow them to complete response forms for data collection. A pilot project in Pulao town (Banga County) suggested that if bears were unsuccessful in attacking a fenced household, they would attack a nearby household instead. Thus the bear-proof fences, although providing protection for enclosed households, could increase the cost for neighbouring households. Therefore, fence sites in this study were chosen so they were located at least 5 km from other households, to ensure that bear visits and attacks at each site were independent, and that bears excluded by the fences did not attack nearby homesteads.

Seven fences were constructed in Baling and seven fences in Nyima starting on 2 January 2009. Construction of all fences was completed in less than 10 days. Fence specifications were refined on the basis of feedback from participants in the pilot scheme in Pulao town, and are shown in Table 1. Fence parts are labelled in Figure 2. Fences were built by herdsmen and an implementation team, and costs include transportation of materials. Internal divisions using mesh fences at 1.1 m high were also added to enclose sheep and goats. Costs were paid in Chinese yuan (CNY) but are shown in US dollars (USD), where 1 CNY = 0.145 USD, based on the average exchange rate in the 4th quarter of 2008. The Wildlife Conservation Society paid 80% of the fence construction costs, and a financial cooperation scheme meant families paid the other 20%. This was reduced to 10% for poorer households, with the remaining 10% of costs borne by the township governments.

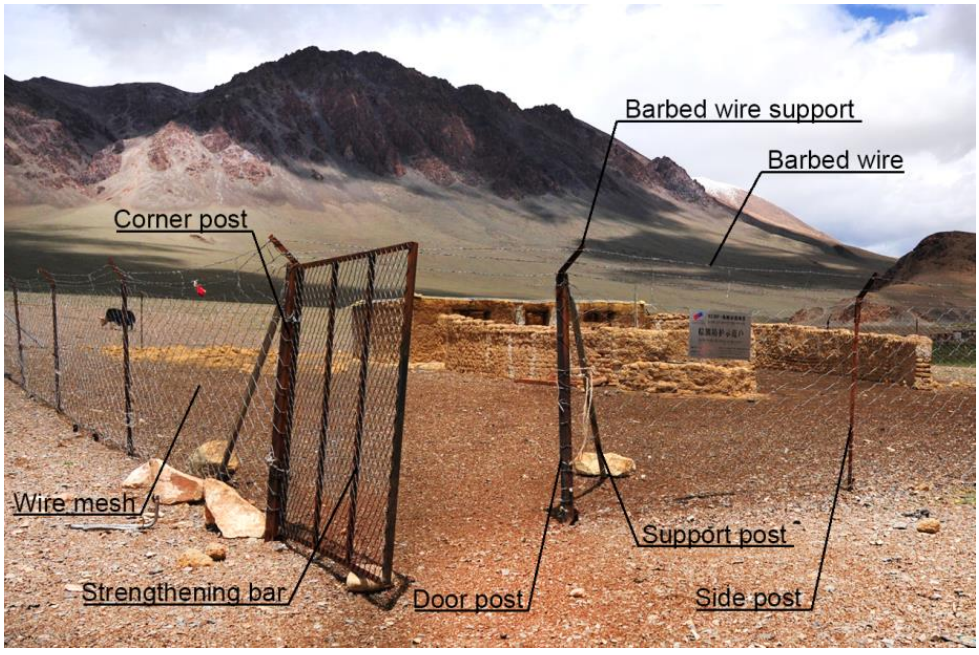

Figure 2. Example of bear-proof fence, showing main components of the construction. Table 1 describes the materials used for each component.

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CONSEQUENCES

Bear visits to fences: The number of bear visits recorded by households decreased after fence construction, from an average of 5.3 visits to each household during 2008 to 2.4 visits in 2009 (Wilcoxon signed rank test, V = 96, $P = 0.007$, $N = 14$). After fences were completed, bears attacked the fences on 11 occasions and entered two compounds. Three fences were damaged and were repaired by the households within the fences using wire and piling tools.

Livestock losses: A total of three animals were lost by households within the fenced areas in 2009 (Table 2), a 98% decrease from 2008 levels. In 2008, an average of 11.6 animals were lost per household, compared to 0.2 animals lost by each household in 2009 ($N = 19$ households). Although a reduction in the number of bear visits could explain these reduced losses, the nine sites which were visited by bears both before and after fence construction lost an average of 2.5 animals (range 0-6.4) per bear visit before fences were constructed, compared with an average of 0.1 animals (range 0-0.5) per visit after fence construction (Wilcoxon signed rank test, V = 28, $P = 0.02$, $N = 9$).

Cost effectiveness: Total compensation costs for livestock lost by the households in the study (based on compensation values set by the Tibetan Autonomous Region government) dropped from USD 7,047 in 2008 (of which USD 4,176 was for Baling town) to USD 131 in 2009 after the fences were constructed (all of which was for Baling Town, Table 2). Fences cost USD 9.56/m to construct and the total cost of constructing all 14 fences was USD 13,325. Assuming 2008 was a typical year for compensation without bear-proof fences, the construction of fences in Baling cost the equivalent of 1.5 years of compensation (seven fences cost USD 6353), and the fences in Nyima cost 2.4 years of compensation (seven fences cost USD 6972). The fences were still standing in September 2013 (Wildlife Conservation Society China Program, unpublished data), 4.8 years after they were built. The fences were in a good state of repair and were expected to continue excluding bears providing any slight damage is repaired as soon as it occurs. The major expenditure for repairs is the purchase of new wire, estimated by the Wildlife Conservation Society field team as less than USD 73 per fence annually, but no data have been collected to support this estimate.

Table 2. Total livestock losses and compensation in 2008 and 2009 for households that had a bear-proof fence constructed in January 2009. Compensation is expressed in USD.

Township	Households		2008	2009
Baling	7	Livestock losses	96	3
		Compensation	4,176	131
Nyima	12	Livestock losses	66	0
		Compensation	2,871	0

Revision of fences specification: Based on the damage to the fences constructed to the specifications given above, the field team at Wildlife Conservation Society recommend the following changes to fence design to make them more robust:

1) Use 10 x 10 cm iron for the corner posts and 5 x 5 cm iron for the side posts.
2) Reinforcement of the thimble connecting door to post.
3) Use diagonal, rather than vertical door strengthening posts.

DISCUSSION

The fences described in this paper significantly reduced household losses to bears in the year following construction. Unfortunately, information on household losses was not collected after the end of 2009, so it was not possible to quantify the extent to which the fences reduced livestock losses after the first year after construction. However, the fences were still standing 4.8 years after completion and any small damage had been repaired by households. The cost of construction was equivalent to 1.5–2.5 years of compensation money for the households in this study. Therefore, in addition to reducing livestock losses for households, bear-proof fences are a less costly strategy to prevent human-bear conflict than compensation from the government alone.

The households in this study were selected due to their high historic losses to bears, and fences may be less cost effective for households which suffer lower levels of loss. For households however, bear-proof fences could be more attractive than compensation, as compensation may not reflect the true cost of losing livestock and payments can be delayed. To receive compensation, the household and the county-level forestry bureau need to collect evidence and apply for compensation to be approved at the provincial to county level. Local forestry bureaus need to check the incident reported by local people, which requires travel in remote places. The compensation process takes time and local households do not always have the capacity to provide all the necessary evidence.

Fenced households lost fewer animals to bears, and there was also some evidence that fences reduced the number of bear visits. Before households were fenced however, inhabitants were often made aware of bear visits to vacant households by the damage they caused to the property. In contrast, if bears approach but do not damage a vacant fenced household, the inhabitants may not be aware they visited, causing a decrease in reported visits. Alternatively, the frequency of bear visits may decrease as bears learn that fenced households are no longer an easy source of food. This theory is supported by a reduction in bear visits in the second half of 2009, but this could be confounded if bear raiding behaviour varies with season (Worthy & Foggin 2008).

Although a cost-effective method for reducing losses to bears, these fences may not change local perceptions of bears. Promoting positive attitudes to bears and helping individuals to understand the value of bears in the landscape could still be necessary to reduce human-bear conflict in this area, particularly as bears not only attack households, but also people herding their sheep. Furthermore, this study could not measure potential transfer of bear attacks from fenced households to households that did not participate in the study or to livestock grazing outside the fences. The spatial distribution of bear attacks would need to be monitored if the program were to be scaled-up. Overall however, bear-proof fences have potential as an effective and cost-saving intervention to reduce human-bear conflict in the Tibetan Autonomous Region of China.

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