兽类学报，2009，29（3）：231－238
Acta Theriologica Sinica

Livestock depredation by Amur tigers in Hunchun Nature Reserve, Jilin, China

LI Bing[1], ZHANG Endi[1*], LIU Zhongbao[2]

(1 *College of Life Science, East China Normal University, Shanghai* 200062, *China*)
(2 *Hunchun National Nature Reserve , Hunchun* 133300, *China*)

Abstract: The Amur tiger (*Panthera tigris altaica*) is endangered in China. Since establishment of the Hunchun Nature Reserve adjacent to Russia and DPR Korea in Jilin Province, in December 2001, the tiger population in this region seems to have increased. Reports of livestock losses are increasing in the reserve. To reduce human-tiger conflicts, we carried out an in-depth analysis of livestock depredation by tigers, based on tiger monitoring data collected from December 2001 to 2007. There were 126 cases in which Amur tigers attacked 204 cattle, horses and dogs between December 2002 and 2007. From 2002 to 2007, livestock losses generally increased, with major increases in 2007. Livestock depredation mainly occurred between April and September. Results suggest no preference for specific domestic animals. Tigers rarely attacked livestock that were less than 1 km from a village, and human disturbance affected utilization of livestock and tiger behavior associated with moving carcasses. An estimated 16 079 kg livestock meat was eaten by tigers, amounting to $76 084 in losses. Attacks occurred more often on southern and eastern aspects, lower altitudes, gentler slopes, greater canopy density, closer to villages and rivers, and farther from roads. Removal of snares in the forest and elimination of new snares is vital to increase ungulate populations, so as to reduce tiger dependence on livestock. Better livestock husbandry techniques and reduction of livestock within Hunchun Reserve can greatly reduce the rate of depredation by tigers. Avoiding disturbance of sites where tigers have already made kills is also likely to reduce rate of killing in some extent

Key words: Amur tiger; China; Hunchun; Jilin Province; Livestock Depredation; *Panthera tigris*

吉林珲春自然保护区东北虎捕食家畜研究

李冰[1]　张恩迪[1*]　刘忠宝[2]

（1 华东师范大学生命科学学院，上海 200062）（2 吉林珲春国家级自然保护区，珲春 133300）

摘要：东北虎在中国已经极度濒危，随着位于中俄朝三国边境地区的吉林珲春自然保护区在2001年底的建成，对虎的保护初见成效。然而保护区内虎频繁捕食家畜，引发了当地居民的不满。为了减缓人虎冲突，寻找东北虎捕食家畜的有关规律，作者开展了东北虎捕食家畜的相关研究。从2001年12月至2007年底，共计有126起，204头家养动物被虎袭击，且呈现逐年上升的趋势。家畜被袭击主要发生在每年的4～9月，没有发现明显的对家畜种的偏好。利用GIS和回归分析表明：1）虎通常不袭击离开村庄小于1 km的家畜；2）人为干扰对家畜的被食用率和虎移动家畜尸体的行为都有显著影响；3）共计有约16 079 kg的家养动物肉被虎食用，造成损失76 084美元；4）对虎袭击地点生态变量的分析表明，东向和南向有更多的家畜被袭击；5）此外，虎多在较低的海拔和坡度、较高的郁闭度，靠近村庄和河流，远离道路等区域捕食家畜。清除套子和防止下套以增加有蹄类的密度对于减少虎捕食家畜非常重要。此外，减少虎袭击地点的人为干扰和改善对家畜的看护也非常关键。

关键词：东北虎；捕食家畜；珲春
中图分类号：Q958　　**文献标识码**：A　　**文章编号**：1000－1050（2009）03－0231－08

1 Introduction

Conservation of large carnivores often presents unique challenges because these species generally need large tracts of land and often kill domestic animals and even people (Miquelle *et al.*, 2005). Across Asia, livestock depredation by tigers has become a serious problem (Bagchi *et al.*, 2003). Livestock depredation and other human-wildlife conflicts often damage the interests of both sides (Cozza *et al.*, 1996) and reduce local people's tolerance to wild animals (Udaya, 1989; Fiallo and Jacobson, 1995; Walpole and Goodwin, 2001). Additionally, human-induced mortality, often a result of such conflicts, is one of the most important threats to large carnivores. Thus resolving conflicts between human and carnivores is key to their survival (Woodruffe and Ginsberg, 1998; Miquelle *et al.*, 2005).

The tiger (*Panthera tigris*) is a symbol of power

基金项目：华东师范大学与国际野生生物保护学会（WCS）的合作研究项目
作者简介：李冰（1977－），女，博士研究生，主要从事东北虎的保护与研究.
收稿日期：2009－01－04；　修回日期：2009－05－11
* 通讯作者，Corresponding author，E－mail：ezhang@mail.ecnu.edu.cn

and beauty in China. But more than a symbol, the tiger is considered a "key species" in biodiversity conservation. Of the remaining subspecies of tiger, the Amur tiger (*P. t. altaica*) is probably the most vulnerable excepting only the South China Tiger (*P. t. amoyensis*) which is believed to be at least ecologically extinct (Tilson, 2004). In China, there are less than 20 Amur tigers in the wild (Yu *et al.* 2000; Li *et al.*, 2001), but tiger predation on livestock has become a problem in China since establishment of Jilin Hunchun National Nature Reserve in December 2001 (Liu *et al.*, 2006).

Our objectives were to determine key factors influencing livestock depredation and to propose measures that might reduce the level of conflict. We hypothesized that:

1) Tigers show preference for particular livestock species;

2) High densities of livestock and human populations in forested areas may increase livestock losses, so reducing livestock density and human activities in forests can reduce conflicts;

3) Tigers normally don't attack livestock close to villages and usually attack at night, so keeping livestock close to villages and keeping them in barns can reduce conflicts;

4) The sites of attacks are influenced by habitat preferences of tigers, so changing grazing sites will help reduce conflicts.

2 Study Area

The Jilin Hunchun National Nature Reserve (JHNNR), with a total area of 1 087 km^2, is located in northeastern Jilin province (130°17′08″ – 131°14′44″E, 42°42′40″ – 43°28′00″N) and borders both Russia and DPR Korea. There are four zones in the reserve, including a core area, buffer zone, experimental zone, and community co-management area (Fig. 1). The reserve, connected with three tiger and leopard (*P. pardus orientalis*) protected areas in Russia, is a key corridor for movement of Amur tigers and Far Eastern leopards among China, Russia and DPRK, and has the highest frequency of tiger occurrence of any reserve in China.

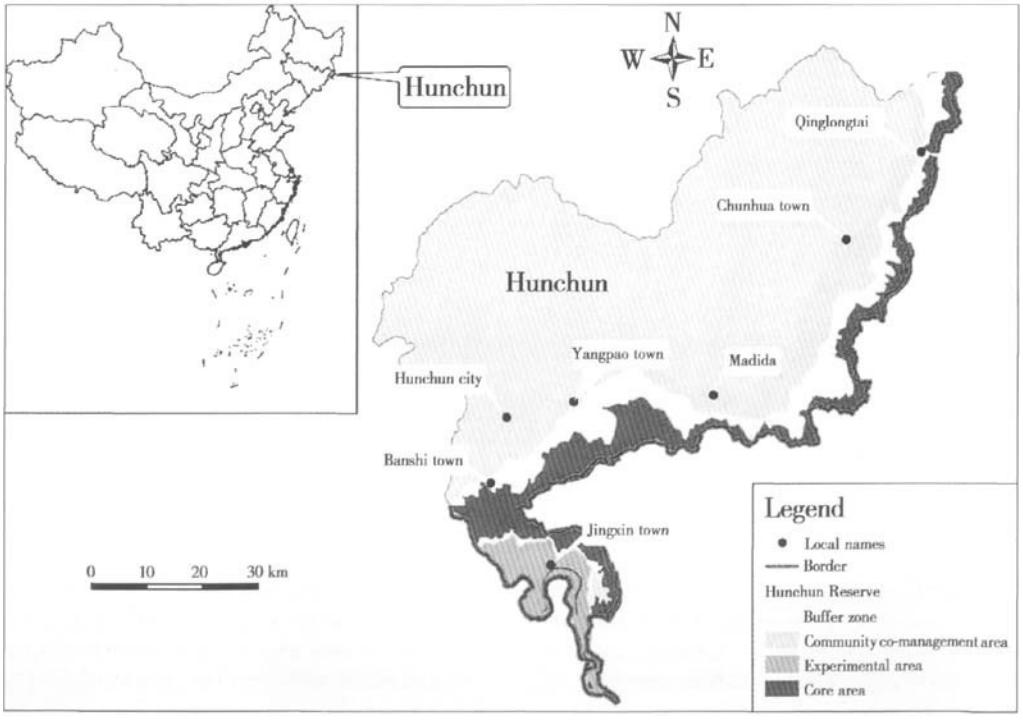

Fig. 1 The Hunchun National Nature Reserve, Jilin, China

As part of the Changbai Mountains, JHNNR is in the temperate zone (continental humid climate of the monsoon), with an average rainfall of 661.0 mm concentrated between July and September (50% of yearly precipitation). In addition to tiger and leopard, large herbivores including red deer (*Cervus elaphus*), sika deer (*Cervus nippon*), roe deer (*Capreolus capreolus*), and wild boar (*Sus scrofa*), also occur in JHHNR (Jilin Hunchun Nature Reserve Scientific Survey and Planning Report, 2007).

There are a total of 29 villages and 14 953 people living within the reserve. Villagers mainly depend upon

agriculture and livestock husbandry, with some forestry, diversified businesses and fishing as well. Livestock husbandry accounts for 17.3% of local residents' income (Choi, 2005). The most common livestock are cattle, hovses, pigs and sheep. Cattle and horses are generally allowed to graze freely from March to November, but are pen-fed during the winter. Pigs are usually penned year-round, and sheep are tended by sheepherders and are brought back in the evening.

The number of tigers in the Hunchun Nature Reserve is uncertain. Tigers can move freely between China and Russia, and monitoring data is not adequate to clearly define the number of tigers, especially residents. Surveys in 1998 - 1999 (Yu *et al.*, 2000) found 3 - 5 tigers in Hunchun area. A winter survey of 2003 - 2005 indicated no more than 7 tigers living in or visiting JHNNR (Li *et al.*, 2008).

3 Methods

3.1 Data collection

Livestock depredation data (December 2001 to December 2007) were collected and recorded in a standard form by trained reserve staff who investigated depredation sites reported by local villagers. Most villagers report livestock losses to the reserve once. But because the compensation scheme was not consistently applied, there were still an estimated 10% ~ 20% of data not collected, either because some villagers were unclear about the compensation scheme, or because by the time reports were made, carcasses were already decomposed and the cause of death could not be determined. In the later part of 2005 and 2006, the compensation scheme was stopped for a year, and thus fewer data were collected than in earlier years.

GPS locations of depredations were required in the standard form, but only 94 accurate locations were useable from the 126 cases of livestock loss. At each site, altitude, slope, aspect, canopy density, forest type, land use type, and distance to closest village, road, and river were recorded. Forests were categorized as mixed broadleaf, Mongolian oak, coniferous forests, mixed deciduous and coniferous, non-forested, and shrubs. Slope, altitude and aspect were extracted by "Raster Surface" in "3D Analyst" tools.

On 10 occasions, we set camera traps adjacent to recent tiger attack sites.

3.2 Data Analysis

Ninety-four points were randomly selected in the reserve and a 20 km buffer zone around the reserve boundary (area outside of China was excluded) as control group ("random sites" hereafter).

We used Pearson correlation to analyze relationship between variables (including elevation, slope, canopy density, and distance to village, road, river) and percent of meat eaten by tiger. Two-sample *t*-tests were used to test the equality of mean depredations per month in frost and non-frost seasons, and differences of continuous variables (including altitude, slope, canopy density, distance to village, river and road) between random sites ($n = 94$) and livestock depredation sites. Chisquare tests were used to test associations between frequencies of forest types and livestock depredation.

Depredation sites with slopes less than 5 degree were considered flat (no aspect). Non-forest sites (canopy density = 0) were removed when comparing canopy density of tiger group and random group.

3.3 Livestock biomass and value estimates

Livestock biomass and monetary values were based on an estimate derived for 2002 - 2005 when the Hunchun Nature Reserve operated a compensation scheme. An increase in price of 10% in 2006 and 30% in 2007 was due to inflation of livestock prices.

Table 1 Estimated biomass and value in Hunchun Nature Reserve

	Weight (kg)	Average price of 2002 - 2005 ($ *)	Price of 2006 ($ *)	Price of 2007 ($)
Adult Bull	300	642	706	835
Adult Cow	280	428	471	556
Adult Horse	300	428	471	556
Calf (one year old)	100	71	78	92
Foal (one year old)	100	71	78	92
Cattle (2-yr old)	220	171	188	222
Horse (2-yr old)	220	171	188	222
Cattle (3-yr old)	250	285	314	371
Horse (3-yr old)	250	285	314	371
Cattle Uncertain age	230	320	352	416
Horse Uncertain age	218	239	263	311
Dog	35	29	32	38

* Rounded number and exchange rate between RMB and American dollar is 7

4 Results

4.1 Livestock killed and prey preference

From December 2001 through 2007, 204 livestock were attacked by tigers: 89.7% were cattle, 7.4% were horses and 2.9% were dogs (See table 2).

Table 2 Livestock and dog loss caused by tigers in Hunchun Nature Reserve from 2001 – 2007

	Livestock and dogs killed			Livestock and dogs injured		
	Cattle	Horse	Dog	Cattle	Horse	Dog
Year	*Bos taurus*	*Equus caballus*	*Canis familiaris*	*Bos taurus*	*Equus caballus*	*Canis familiaris*
Dec. 2001 *	–	1	–	–	–	–
2002	11	3	–	–	–	–
2003	13	3	2	4	–	–
2004	22	6	1	3	1	–
2005	21	–	–	3	–	–
2006	22	–	3	5	–	–
2007	68	1	–	11	–	–
Total	157	14	6	26	1	–

* Records begin in December 2001

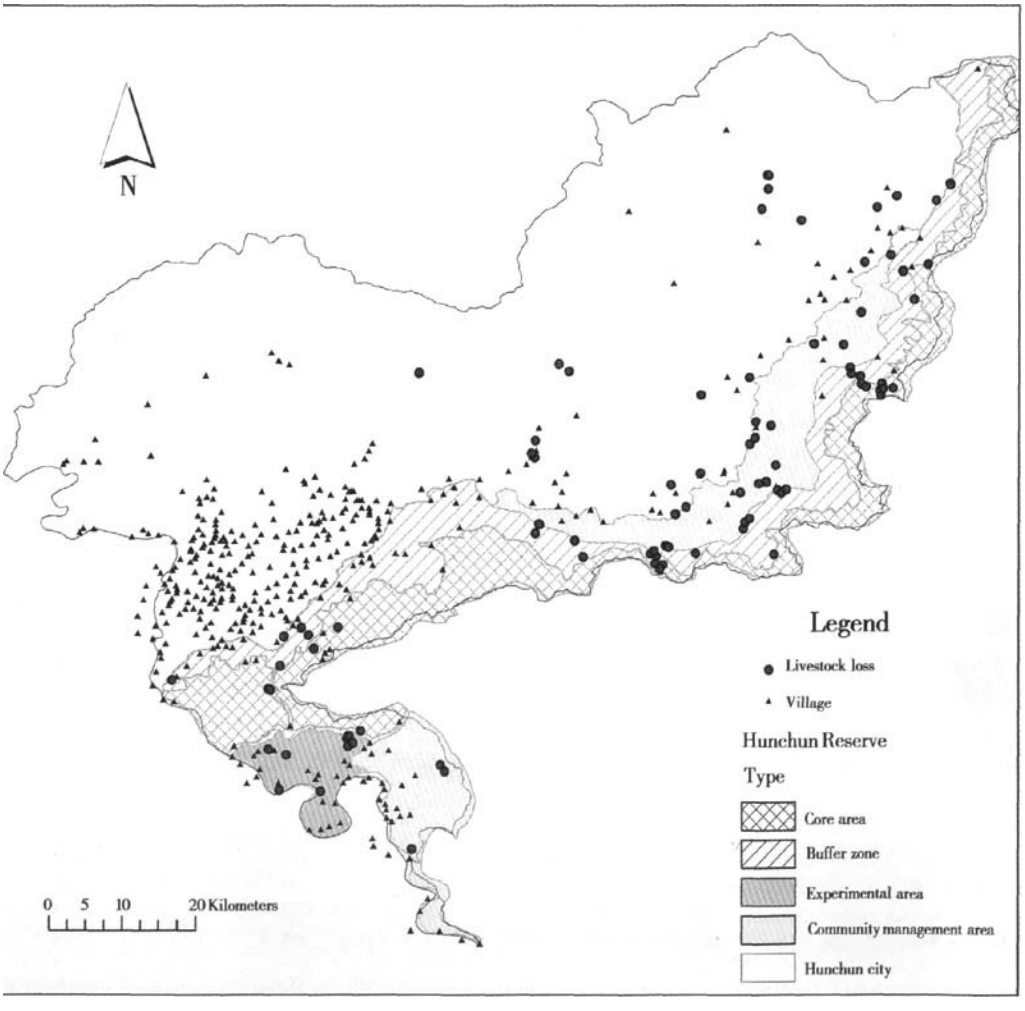

Fig. 2 Livestock depredation sites in and around Jilin Hunchun National Nature Reserve from December 2001 – 2007.

There were no data on numbers of domestic animals kept by local people within Hunchun Nature Reserve. According to government data in Chunhua township, which had the greatest density of tigers and greatest livestock loss from 2002 – 2003, the ratio of cattle to horses was approximately 5∶1 (4 904 – 4 976 cows and 976 – 988 horses in villages occurring within Chunhua township). Livestock lost in Chunhua were 29 cattle and 5 horses(5.8∶1).

4.2 Analysis of attacks

In most of cases (69%), tigers attacked only one animal, but in 31% of depredations of more than one

domestic animal were found at the same site on the same day (See table 3).

Table 3 Number of livestock attacked by tigers per depredation event

	One animal	Two animals	More than two
Cases	87	26	13
Percentage	69.0%	20.6%	10.3%

Of the 204 animals attacked, 87.4% were killed, the rest only incurring injuries (table 2). In 25% of the 71 cases in which cows and horses were killed, the tiger did not eat the animal, and in 41.8% of the cases, 50% or less of the available meat was eaten. In 32.7% of the cases, more than 50% of which was consumed (See Fig. 3).

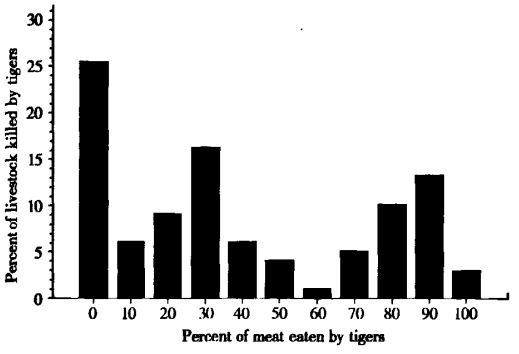

Fig. 3 Percent of meat eaten by tigers

Elevation was the only variable found to have a significant relationship with percent of meat eaten (Table 4).

An estimated total of 16 079 kg of livestock meat was eaten by tigers, at a total loss of $76 084 to villagers (Table 5).

Table 4 Pearson correlations between percent of meat eaten and other variables

Variables	r	P (2-tailed)
Elevation	0.252	0.014
Slope	0.016	0.875
Canopy density	0.076	0.467
Distance from village	0.123	0.236
Distance from road	0.040	0.704
Distance from river	0.064	0.539

4.3 Spatial and temporal patterns of attacks

The average distance of attacks to villages was 3.13 km. Most sites (94%) were at least 1km from villages (Table 6).

From 2002 – 2006, the number of livestock losses is fluctuant, however in 2007 the losses increased to over 3 times of 2006 (See Fig. 4).

There was considerable seasonal variation in occurrence of livestock depredations. The livestock depredation mainly occurred from April to September which is the frost season (Fig. 5) and highest in May. In frost season, from October to March of next year, the mean number of livestock losses per month ($\bar{x}$ = 4.17 ± 2.86) were lower than during warmer months (x = 16.83 ± 3.54, t = 6.814, df = 10, P < 0.0001).

Table 5 Livestock biomass eaten by tigers and economic loss to local people

Year	Cattle (biomass/$)	Horse (biomass/$)	Dog (biomass/$)	Total (biomass/loss)
Dec. 2001	—	240kg / $428	—	240kg / $428
2002	1026kg/ $3872	565kg/ $789	21kg/ $29	1612kg/ $4 690
2003	1250kg/ $5984	390kg/ $789	42kg/ $58	1682kg/ $6 831
2004	1800kg/ $10560	210kg/ $471	33kg/ $29	2043kg/ $11 060
2005	1698kg/ $6628	—	—	1698kg/ $6 628
2006	1836kg/ $9936	—	66kg/ $87	1902kg/ $10 023
2007	6659kg/ $35868	240kg/ $556	—	6899kg/ $36 424
Total	14269kg/ $72848	1645kg/ $3033	162kg/ $203	16076kg/ $76 084

Table 6 Distances of tiger attacks to villages, 2002 – 2007

	Distance to villages (n = 94)					
	Total	<1 km	1 – 2 km	2 – 3 km	3 – 5 km	>5 km
Percentage	6.4%	29.8%	21.3%	23.4%	19.1%	100%
Mean ± SD (m)	774 ± 132	1407 ± 244	2463 ± 349	3746 ± 532	6889 ± 1849	3201 ± 2220

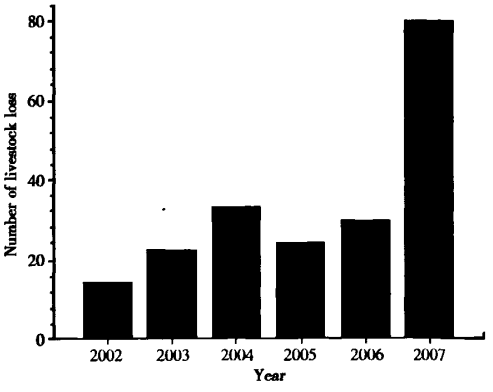

Fig. 4 Number of livestosk loss from 2002 - 2007

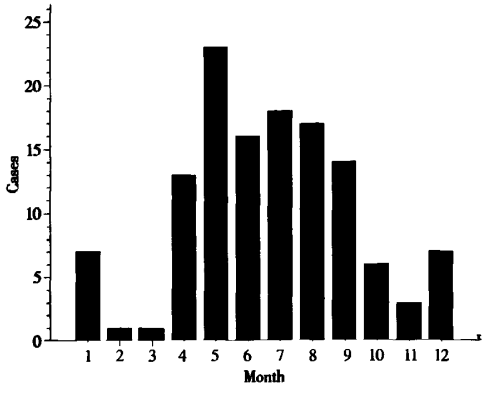

Fig. 5 Cases of livestock loss in each month from December 2001 - December 2007

The total number of camera trap nights adjacent to tiger depredation sites was 22. We obtained 4 photographs of tigers, all at night when tigers evidently returned to livestock carcasses. We documented an additional 34 instances in which livestock carcasses were found fresh in the morning, suggesting that tigers probably attacked livestock the previous evenings . Timing of the other cases was unclear, but in no case did we have evidence that tigers attacked livestock during daytime hours.

5 Ecological variables analysis of predation locations

5.1 Aspect

Attacks occurred more commonly on south and east than other aspects. (Fig. 6).

5.2 Forest type

Most livestock depredations occurred in Mongolian oak (*Pinus koraiensis siebold*) forests and broad-leafed forest, but these were also the dominant forest types in the region, suggesting that tigers actually displayed no preference in livestock depredation among different forest types (x^2 = 5.412, df=5, P = 0.368; Fig. 7).

5.3 Continuous variables analysis

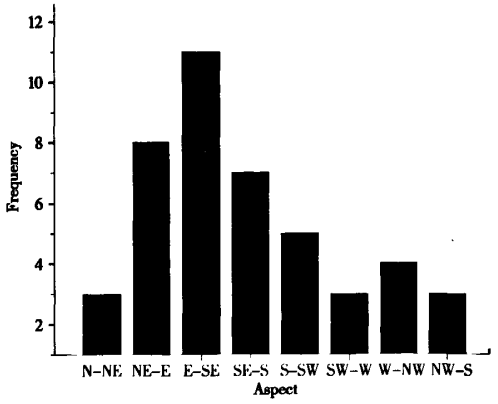

Fig. 6 Aspect of tiger attack site with slope over 5 degree

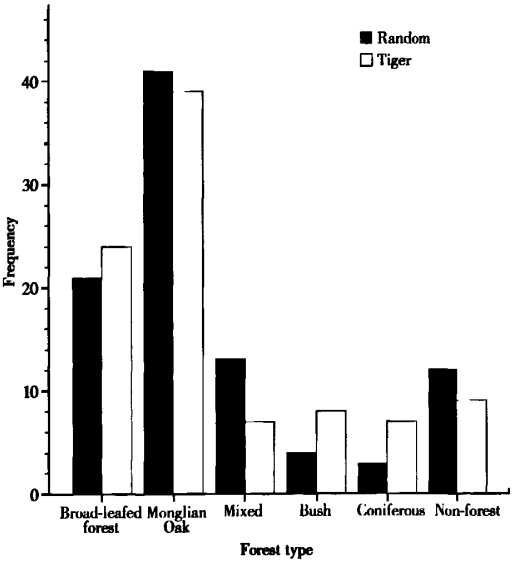

Fig. 7 Forest type of tiger attack site

The risk of livestock depredation was greater at sites at lower elevations, gentler slopes, higher canopy density, closer to villages and rivers, and farther from roads than at randomly placed sites (Table 7).

6 Discussion

6.1 Tiger preferences among domestic animals

According to data from Chunhua, tigers did not show an obvious preference between cattle and horses. Amur tigers prefer wild boar and red deer rather than smaller-sized ungulates (e. g. , roe deer and sika deer, Miquelle *et al.* , 1996). Cattle and horse are similar in size or larger than red deer and wild boar, which might be the reason why tigers have no obvious preference between these two animals. In Russia, dogs are the most common domestic animals killed by tigers, followed by cows and horses (Miquelle *et al.* , 2005). However, in Russia, dogs are commonly used during hunting, or chained outside villages houses, making

them very susceptible to tiger predation, whereas in China, dogs are normally kept as pets, only some frog breeders (who live in the forests) and a few hunters commonly bring dogs to forested areas. Dogs are less likely to be killed when not in forest areas.

Table 7 Two-sample *t*-tests comparing characteristics of livestock depredation sites and randomly selected sites (n = 94, two-tailed)

Variables	Tiger attack (Mean ± SD)	Random (Mean ± SD)	t	P
Elevation	223 ± 111 m	340 ± 221 m	4.593	$P<0.001$
Slope	5.7 ± 4.8 degree	10.1 ± 7.3 degree	4.877	$P<0.001$
Canopy density*	0.56 ± 0.23%	0.51 ± 0.31%	2.735	$P=0.007$
Dist-village	3128 ± 2256 m	3943 ± 2878 m	2.161	$P=0.032$
Dist-road	1357 ± 1586 m	454 ± 380 m	−5.368	$P<0.001$
Dist-river	233 ± 243 m	2023 ± 1531 m	11.191	$P<0.001$

* *Non-forest sites (canopy density = 0) were removed. Number of tiger group is 87, random group is 71.*

6.2 Analysis of tiger attacks

We separated the percent of cattle meat eaten by tigers into three categories; cases in which no meat is eaten, less than 30% is eaten and when 80% − 90% is eaten. All of the cases in which tigers did not consume any meat occurred when tiger attacked more than one animal (except 4 cases of killing dogs), and in all of these cases, carcasses of livestock were very close to each other. In contrast, at sites where only one animal was killed there was no evidence of other livestock in the vicinity. These observations suggest that when livestock were in group or in high density, tigers may kill more than one.

When tigers did eat livestock, the amount eaten may relate to whether they were disturbed or not. After killing prey, tigers normally spend 2 − 4 days to consume the animal (Miquelle *et al.*, 1996). However, if there is human disturbance at kill sites, Amur tigers will often abandon kills (Kerley *et al.*, 2002). Within the reserve, our camera-traps recorded tigers returning to carcasses five times, always during evening. Despite evidence that tigers may abandon kills where human disturbance occurs, we found that only elevation was significantly related to percent of meat eaten, other variables (e. g., distance to road or distance to village) did not affect tiger behavior. However, other unmeasured factors may have been more important in determining whether kills were abandoned due to disturbance. For instance, the time when local people find and report the livestock loss could be an important factor, because if the livestock were found immediately, usually the meat would be taken by the villager, and the tiger would have no opportunity to return to the kill. In the cases when tigers were caught by camera traps, people were instructed to avoid kills sites. In Russia, tigers consumed an average of 97% of the available meat when they were not disturbed by humans (Kerley *et al.*, 2002). But the rate of utilization of the kill also depends on availability of food in a particular time period, the animals' level of hunting experience and the absence or presence of cubs (Pikunove *et al.*, 1978). Human disturbance may also increase the depredation rate, as tigers frightened from kills without consuming meat will have to kill more frequently. So reducing human disturbance at kill sites may decrease the rate of depredation.

6.3 Distance to villages and temporal patterning of attacks

In only 6.4% of cases did tigers kill domestic animals within 1 km of a village. In winter, because livestock are usually kept in barns, losses were few. From April to September, most livestock are released to the forest to graze, making them highly vulnerable to tiger depredation. All the camera trap pictures and fresh kill sites in JHNNR showed that tigers more likely to attack livestock at night. Keeping livestock in barns at night throughout the year, and keeping them closer to villages would help reduce the conflict.

Losses in the Hunchun Nature Reserve are fluctuant. However since compensation was halted from late 2005 to 2006, motivation to report the losses during the time was lower, hence the true trend of livestock losses might be hidden. The increase in 2007 appears dramatic; Based on available information (yearly reports of tiger sightings), there is not appear to be a significant increase in the tiger population between 2002 and 2006 (Li *et al.*, 2008), but data are relatively crude. Hence, the trend may represent an increasing tiger population, an increasing tendency of certain individual tigers to prey on livestock, or greater susceptibility of livestock.

6.4 Variables analysis

Attacks occurred more commonly on east and southern aspects, but it is not clear whether this demonstrates tiger hunting preferences or livestock grazing preferences. In Russia, winter attacks by tigers were more common on southern slopes, probably because snow cover is less, and ungulates are more commonly found on this aspect (Sokolovm *et al.*, 1979). Although research in Sichuan Province found no slope preferences of livestock (Ran *et al.*, 2003), it is more likely that cattle are more responsive to environmental parameters like snow cover in Hunchun.

In the Hunchun Reserve and adjacent areas, each village has its own pastures, normally not very far away from the villages. Most livestock losses occurred in

these pastures, which can explain why the sites are closer to villages than random sites. Tigers also preferred sites at lower elevations and gentler slopes, similar to reports in the Russian literature (Sokolovm *et al.*, 1979). Tigers also preferred sites with higher canopy density and further from roads. Because distance from road ($r = 0.375$, $P < 0.01$) and canopy density ($r = 0.298$, $P < 0.01$) were both significantly correlated with distance from villages, it appears that tigers prefer sites with less human disturbance. The reason why depredation sites were significantly closer to rivers is not clear, but tigers often travel in valleys along river bottoms (Sokolovm *et al.*, 1979).

In Hunchun Nature Reserve, direct human harvest is apparently responsible for severe depression of ungulate density, which is estimated at only 0.630/km^2 (Li Bing, unpublished data) compared to an estimated 3.7 – 6.8/ km^2 in a more northerly site in Russia (Stephens *et al.*, 2006a, 2006b). A lach of natural prey may explain why attacks on livestock are so prevalent in Hunchun. Hence, removal of snares (the primary means of taking ungulates in this region), and preventing further setting of snares is critical. Keeping livestock closer to villages be likely to reduce losses, as would the presence of a shepherd to tend herds (something not practiced in the region). Ultimately, removal of livestock from Hunchun Reserve is vital to allow full recovery of natural prey, and eliminate the conflict between tigers and livestock. Breeds of cattle that can be barn-fed year-round would provide a source of income for local people, yet eliminate the need to graze cattle in forest lands where the risk of depredation will always be high. Finally, avoiding disturbance of sites where tigers have already made kills is likely to reduce, to some extent the rate of killing as tigers frightened off of one kill will only need to kill again to obtain their next meal. Education of local people to improve husbandry techniques and reduce conflicts will be a necessary component in the resolution of this problem.

Acknowledgements: I thank Wang Yuanrong, head of the Conservation Department of Jilin Hunchun Nature Reserve, who did a lot of work to collect data. I thank my colleague Dale Miquelle who provided generous support on data collection and training. I thank Lucy Tallents and Paul Johnson in Wild CRU of Oxford University for technical and statistic guide, and most importantly, I'd like to thank WCS for financial and technical support to this research.

References:

Bagchi S, Goval S P, Sankar K. 2003. Prey abundance and prey selection by tigers in a semiarid, dry deciduous forest in western India. *Zoo*(Lond.), **260**:285 – 290.

Choi Hee-lan. 2005. Status of Jilin Hunchun Amur Tiger Nature Reserve and suggestions. *Environment Education*, (1):62.

Cozza K, Fico R, Battistini L, Rogers E. 1996. The damage-conservation interface illustrated by predation on domestic livestock. *Biological Conservation*, **78**(3): 329 – 336.

Fiallo E A, Jacobson S K. 1995. Local communities and protected areas: attitudes of rural residents towards conservation and Machalilla National Park, Ecuador. *Environmental Conservation*, **22**(3):241 – 249.

Kerley L L, Goodrich J M, Miquelle D G, Smirnov E N, Quigley H B, Hornocker M G. 2002. Effects of roads and human disturbance on Amur tigers. *Conservation Biology*, **16** (1) :97 – 108.

Li B, Zhang E D, Zhang Z H, Liu Y. 2008. Preliminary monitoring of Amur tiger conservation and population restoration in Jilin Hunchun National Nature Reserve. *Acta Theriologica Sinica*, **28** (4) : 333 – 341.

Li T, Jiang J S, Wu Z, Han X D, Wu J C, Yang X J. 2001. Survey on Amur tinger in Jilin Province. *Acta Theriologica Sinica*, **21**(1):1 – 6.

Liu Y, Zhang E D, Li Z H, Chen X J. 2006. Amur tiger predation on livestock in Hunchun Nature Reserve, Jilin, China. *Acta Theriologica Sinica*, **26** (3) : 213 – 220.

Miquelle D G, Smirnov E N, Quigley H G, Hornocker M, Nikolaev E G, Matyushkin E N. 1996. Food habits of Amur tigers in Sikhote-Alin Zapovednik and the Russian Far East, and implications for conservation. *J Wildl Res*, **1**(2):138 – 147.

Miquelle D G, Nikolaev I G, Goodrich J, Litvinov B, Smirnov E N, Suvorov E. 2005. Searching for the coexistence recipe: a case study of conflicts between people and tigers in the Russian Far East. In: Woodruffe R, Thirgood S eds. People and Wildlife: Conflict or Coexistence? Cambridge: Cambridge University Press, 305 – 322.

Pikunov D G, Bazylnikov V I, Bromley C F. 1978. Hunting and Stalking of Prey by the Amur Tiger. 1978 Internationales Tiger symposium.

Ran H J, Liu S Y, Wang H J. 2006. Habitat selection by giant pandas and grazing livestock in the Xiaoxiangling Mountains of Sichuan Province. *Acta Ecologica Sinica*, **11**:57 – 63.

Sokolovm V E, Abramov V K, Pikunov D G. 1979. Biogeographical and anthropogenic aspects of the distribution of *Panthera tigris altaica* in the South of the Soviet Far East. In: Komitet A ed. Okhrana I Zaschita Okruzhaiuschey Sredy. Sectsia A II. Tezisy dokladov. 86 – 87.

Stephens P A, Zaumyslova O Yu, Miquelle D G, Myslenkov A I, Hayward G D. 2006a. Estimating population density from indirect sign: track counts and the Formozov-Malyshev-Pereleshin formula. *Animal Conservation*, **9**: 339 – 348.

Stephens P A, Zaumysolva O Yu, Hayward G D, Miquelle D G. 2006b. Analysis of the long-term dynamics of ungulates in Sikhote-Alin Zapovednik, Russia, Far East. Report to Sikhote-Alin Zapoveduik, USDA Forest Service and WCS.

Tilson R, Hu D F, Muntifering J, Nyhus P J. 2004. Dramatic decline of wild South China tigers *Panthera tigris amoyensis*: field survey of priority tiger reserves. *Oryx*, **38** (1):40 – 47.

Udaya Sekhar N. 1989. Crop and livestock depredation caused by wild animals in protected areas: the case of Sariska Tiger Reserve, Rajasthan, India. *Environmental Conservation*, **25**(2):160 – 171.

Walpole M J, Goodwin H J. 2001. Local attitudes towards conservation and tourism around Komodo National Park, Indonesia. *Environmental Conservation*, **28**(2):160 – 166.

Yu X C, Sun B G, Sun H Y, Guan G S, Zhou X B. 2000. Population and distribution of Amur tiger in Heilongjiang Province. *Chinese Wildlife*, **21**(2):14 – 16.

吉林珲春自然保护区东北虎捕食家畜研究

作者： 李冰， 张恩迪， 刘忠宝， LI Bing， ZHANG Endi， LIU Zhongbao
作者单位： 李冰,张恩迪,LI Bing,ZHANG Endi(华东师范大学生命科学学院,上海,200062)， 刘忠宝,LIU Zhongbao(吉林珲春国家级自然保护区,珲春,133300)

刊名： 兽类学报 ISTIC PKU
英文刊名： ACTA THERIOLOGICA SINICA
年，卷(期)： 2009,29(3)

参考文献(19条)

1. Miquelle D G;Smirnov E N;Quigley H G;Hornocker M Nikolaev E G Matyushkin E N Food habits of Amur tigers in Sikhote-Alin Zapovednik and the Russian Far East,and implications for conservation 1996(02)

2. Liu Y;Zhang E D;Li Z H;Chen X J Amur tiger predation on livestock in Hunchun Nature Reserve,Jilin,China[期刊论文]-Acta Theriologica Sinica 2006(03)

3. Li T;Jiang J S;Wu Z;Han X D Wu J C Yang X J Survey on Amur tinger in Jilin Province[期刊论文]-Acta Theriologica Sinica 2001(01)

4. Li B;Zhang E D;Zhang Z H;Liu Y Preliminary monitoring of Amur tiger conservation and population restoration in Jilin Hunchun National Nature Reserve[期刊论文]-Acta Theriologica Sinica 2008(04)

5. Kerley L L;Goodrich J M;Miquelle D G;Smirnov E N Quigley H B Hornocker M G Effects of roads and human disturbance on Amur tigers[外文期刊] 2002(01)

6. Fiallo E A;Jacobson S K Local communities and protected areas:attitudes of rural residents towards conservation and Machalilla National Park,Ecuador 1995(03)

7. Cozza K;Fico R;Battistini L;Rogers E The damage-conservation interface illustrated by predation on domestic livestock 1996(03)

8. Choi Hee-lan Status of Jilin Hunchun Amur Tiger Nature Reserve and suggestions 2005(01)

9. Yu X C;Sun B G;Sun H Y;Guan G S Zhou X B Population and distribution of Amur tiger in Heilongjiang Province 2000(02)

10. Walpole M J;Goodwin H J Local attitudes towards conservation and tourism around Komodo National Park,Indonesia[外文期刊] 2001(02)

11. Udaya Sekhar N Crop and livestock depredation caused by wild animals in protected areas:the case of Sariska Tiger Reserve,Rajasthan,India 1989(02)

12. Tilson R;Hu D F;Muntifering J;Nyhus P J Dramatic decline of wild South China tigers Panthera tigris amoyensis:field survey of priority tiger reserves[外文期刊] 2004(01)

13. Stephens P A;Zaumysolva O Yu;Hayward G D;Miquelle D G Analysis of the long-term dynamics of ungulates in Sikhote-Alin Zapovednik,Russia,Far East 2006

14. Stephens P A;Zaumyslova O Yu;Miquelle D G;Myslenkov A I Hayward G D Estimating population density from indirect sign:track counts and the Formozov-Malyshev-Pereleshin formula 2006

15. Sokolovm V E;Abramov V K;Pikunov D G Biogeographical and anthropogenic aspects of the distribution of Panthera tigris altaica in the South of the Soviet Far East 1979

16. Ran H J;Liu S Y;Wang H J Habitat selection by giant pandas and grazing livestock in the

Xiaoxiangling Mountains of Sichuan Province 2006(11)

17. Pikunov D G;Bazylnikov V I;Bromley G F Hunting and Stalking of Prey by the Amur Tiger 1978

18. Miquelle D G;Nikolaev I G;Goodrich J;Litvinov B,Smirnov E N,Suvorov E Searching for the coexistence recipe:a case study of conflicts between people and tigers in the Russian Far East 2005

19. Bagchi S;Goval S P;Sankar K Prey abundance and prey selection by tigers in a semiarid,dry deciduous forest in western India 2003