

Local villagers' perceptions of wolves in Jiuzhaigou County, western China

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While there have been increasing numbers of reports of human-wolf conflict in China during recent years, little is known about the nature of this conflict. In this study, we investigated local villagers' perceptions of wolves in Jiuzhaigou County, western China. Using questionnaires and semi-structured interviews, we sampled a subset of the local population who were more likely to have had experience with wolves. Most of the respondents (73%, 73/100) reported an increase in wolf populations in the past 10 years. During the preceding three years, most (83.8%, 83/99) families of the respondents grazed livestock on alpine pastures. Seventy-nine point five percent (66/83) of these families reported that their livestock suffered from depredation by wolves, with a mean annual livestock mortality rate of 24.8%. Eighty-four percent (84/100) of the respondents had a negative attitude to wolves, despite a prevalent Tibetan culture that favors the protection of wildlife. People's negative attitude was directly related to the number of livestock owned by their family. Those with a larger number of livestock were more likely to have a negative attitude towards wolves. Factors such as ethnicity, age and education level did not influence people's attitudes to wolves. We suggest that improved guarding of livestock and provision of monetary support on human resources and infrastructure may mitigate human-wolf conflicts in this region.

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18 Introduction

19 Conflicts between wolves and humans are common worldwide, because of human fear of wolves and
 20 in particular, financial loss due specifically to injury to and loss of livestock that wolves cause (Mech
 21 & Boitani 2003; Treves & Karanth 2003; Bisi et al. 2007). As wolf populations expand or humans
 22 encroach on their habitats, economic losses to wolves increase and conflicts have become increasingly
 23 likely, presenting unique challenges for the conservation and management of wolves (Mech & Boitani
 24 2003; Naughton-Treves, Grossberg & Treves 2003; Bisi et al. 2007; Lescureux & Linnell 2013).

25 To conserve wolves, many researchers have conducted studies aimed at understanding the
 26 conflicts. Managers need to know the perceptions and attitude of local people to wolves and their
 27 conservation programs. In particular, by determining which people are more negative towards wolves,
 28 managers are potentially able to find solutions to improving people's tolerance towards wolves (Treves
 29 & Karanth 2003; Suryawanshi et al. 2013). It has been pointed out that people's attitude depends
 30 mainly on their residence, age, gender, education and income level, and former experience with wolves
 31 (for a review of 38 surveys see Williams, Ericsson & Heberlein 2002; Ericsson & Heberlein 2003;
 32 Naughton-Treves, Grossberg & Treves 2003; Røskoft et al. 2007; Skogen & Thrane 2007). Yet, it is
 33 hard to find a widely accepted management policy, because of regional variation and different factors
 34 affecting attitudes (Bjerke, Reitan & Keller 1998; Bisi et al. 2007). Given this, one has to learn more
 35 about the characteristics of human-wolf conflicts and human attitudes towards wolves, especially for
 36 regions where conflicts have been reported frequently but available knowledge is very scarce.

37 China has a large wolf population which is mainly distributed in areas with relatively few
 38 anthropogenic changes, in the Qinghai-Tibet Plateau, the Mongolia Plateau and the Northeast Plain. It
 39 was estimated to have a population of about 6,000 individuals (Wang 1998; but around 12,500
 40 individuals, see Mech & Boitani 2003), which appeared to be declining owing to habitat degradation
 41 across its ranges (Yang 2008). In 1998, it was listed as a vulnerable species in the China Red List

(Wang 1998). Since then, all hunting has been banned for this legally protected animal. In recent years in China, there have been increasing reports of injury and loss wolves caused especially to livestock, resulting in increase in human-wolf conflicts (Yang 2008; Zhang et al. 2010; CNC 2012; Li et al. 2013; ScienceNews 13). Yet, the published literature on this topic is scarce. There have not been any national preconditions of planning policies focusing on the wolf, except for some involving wolves, for example auction licenses for hunting wild animals (BBC News 2006), and eco-compensation in mitigating human-wildlife conflicts (Xinhuanet 2014; Yunnan.cn 2014).

In this study, we learned about local villagers' perceptions of wolves Jiuzhaigou County, where wolf depredation on livestock has been reported increasingly and the local government is considering management plans for wolves. We aimed to determine wolf population trends, since there have been no data available on the wolf populations in this area and related ranges. Furthermore, we aimed to determine the level of livestock depredation caused by wolves, and then how people's attitude toward wolves was related to socioeconomic variables, specifically religious belief (e.g., Liu et al. 2011) and livestock ownership (e.g., Tuğ 2005), which are poorly understood.

Methods

Ethics statement

The study conformed to the Declaration of Helsinki, and the Ethics Committee of Pingdingshan University approved the research protocol (Ref: 2012003). Verbal informed consent was obtained from all the subjects prior to participation.

Study area

We conducted the study in Jiuzhaigou County (N 32°53'–33°43', E 103°27'–104°26'; Fig. 1), Aba Tibetan and Qiang Autonomous Prefecture of northwestern Sichuan Province, western China. The county lies at the northeastern edge of Qinghai–Tibet Plateau and is famous for its Jiuzhai Valley

66 National Park and the traditional cultures of its inhabitants. The area is 5,290 km², with an elevation
67 ranging from 1,000 m to 4,500 m. The climate is subtropical to temperate monsoon with a mean annual
68 temperature of 12.7 °C. Total annual rainfall is 550 mm, with 80% of rainfall occurring between May
69 and October. The county comprises 17 townships and 120 villages, inhabited by Tibetan, Qiang, Hui,
70 Han and other ethnic groups. In 2011, the county's population was 66,246, with a minority population
71 (ethnic groups other than Han) of 25,090.

72 It has 3,570 km² of forested lands (covering about 67% of the total area), and is the second
73 largest forest area in Sichuan Province. It is rich in alpine grasslands, especially in the northern part,
74 with an area of about 1,200 km² (Chen 2011). Livestock grazing occurs mainly in the northern region.
75 Yaks are the most common livestock species grazed, but there are a few sheep and goats. Livestock are
76 herded to alpine pastures except during extreme winter when they are herded in the cropland around
77 the villages or are stall-fed inside the villages. Livestock of each village graze in exclusive pastures.
78 Every several families take turns at herding the entire village's stock. Commonly, a couple of people
79 herd the livestock, with the use of one or two shepherd dogs occasionally. The livestock are usually left
80 to range freely on the daytime. At night, the herders bring them back to a protective corral or barn,
81 which are poorly built with low walls and no ceiling.

82 Wolves are one of the most important animal species in the local ecosystems. Their large
83 natural prey species are ungulate animals including *Elaphodus cephalophus*, *Capreolus capreolus*,
84 *Capricornis sumatraensis*, *Naemoredus goral*, and *Pseudois nayaur*; small are *Marmota himalayana*,
85 *Lepus oiostolus*, and *Ochotona thibetana*, and some Galliformes such as *Tetraogallus tibetanus*,
86 *Tetraophasis obscurus*, *Perdix hodgsoniae*, *Itaxis cruentus*, *Pucrasia macrolopha*, and
87 *Chrysolophus pictus*. However, their abundances are low (SPAFS 2004; SCUSLS 2011). In the area,
88 livestock depredation by wolves has been reported frequently in recent years, whereas there are few



89 reports on wolf attacks on humans. The local people reported that wolves usually wandered in groups,
 90 and attacked their livestock either diurnally or nocturnally.



91 Fieldwork

92 We carried out the fieldwork in April and May 2012. Following advice from the local forestry bureau,
 93 we conducted an interview survey in the northern region. The villages we sampled were those which
 94 were near pastures and reported frequently wolf depredation on livestock to the local forestry bureau,
 95 but meanwhile we selected randomly three villages with low reported livestock depredation. The
 96 people we interviewed were those who were 18 years or older and who grazed their livestock, collected
 97 herbs or mushrooms, or carried out other activities in forests and pastures, as they had a better
 98 knowledge of the population and activities of wolves (Gros 1998). To foster a comfortable, non-
 99 intimidating information exchange process with local residents, the interviews did not include any
 100 government staff, and we explained to local residents that the interview was for scientific research
 101 purposes only (Kvale 1996).

102 During interviews, we used a semi-structured questionnaire to minimize the influence of the
 103 questions on the response (Wengraf 2001). Interviews were performed orally with responses recorded
 104 immediately post-interview into the standardized questionnaire. First, we recorded respondents'
 105 personal characteristics, including ethnicity (a variable correlated with the religious belief system),
 106 gender, age and education level (three levels: "illiterate", "elementary school", and "secondary and
 107 above"). We did not ask their household incomes, because a pilot survey found it difficult to get the
 108 true value from respondents. Second, we asked for information about livestock in the past 3 years,
 109 including the annual number of livestock grazed by each family and the annual number of livestock
 110 depredated by wolves. Third, we asked their opinions about wolf population trends in their areas over
 111 the past 10 years ("increase", "stable", and "decrease"). Finally, we assessed their attitudes towards

wolves. We included three questions as proxy measures for attitude: (1) “What do you think of wolves?”; (2) “What do you intend to do in response to livestock depredation by wolves?”; (3) “Do you think that wolves should be protected? If a person thought wolves were bad and detrimental, wanted to kill wolves who were attacking their livestock, and did not wish to protect wolves, we considered that the person was negative towards wolves; if the opposite were the case, we considered the person to have a positive attitude towards wolves. If a person had no strong opinion to the questions, we considered the person to have a neutral attitude towards wolves. If the respondent showed a positive attitude in response to some questions and a negative attitude in response to others, we defined this as a mixed response.

Data analysis

We first calculated descriptive statistics of responses to analyze the basic information from the interviews. We examined how people’s attitudes towards wolves were affected by variables of personal characteristics (including ethnicity, age, and education level; gender was not included in the analysis because of only a few respondents were women), and by variables relating to livestock (i.e. annual number of livestock grazed and annual percentage of livestock depredated by wolves). We excluded samples with mixed opinion about our measures and pooled positive and neutral attitudes due to the small number of responses in these categories. We then conducted a binary logistic regression, where a totally negative attitude was scored as 1 while a positive or neutral attitude was scored as 0. In the regression, annual percentage of livestock depredated was considered 0 if there was no livestock grazed (noting that this applied only to the regression and not to the previous descriptive statistics). Categorical variables including ethnicity and education level were converted into a set of dichotomous, dummy-coded variables. For ethnicity, we set “Tibetan” as the reference, and for education level we set “illiterate” as the reference.

135 We used the Akaike information criterion corrected for small sample size (AICc) to compare
 136 statistical models constituting different combinations of variables. We calculated ΔAICc , which means
 137 the difference between the model with the lowest AICc and the other models in the model set, as a
 138 measure of how much likely a model is the best one. The model with the lowest AICc was selected as
 139 the best model when ΔAICc between it and the second lowest-AICc model was larger than two
 140 (Burnham & Anderson 2002). Given $\Delta\text{AICc} < 2$ for several models, we used model averaging over all
 141 candidate models (Burnham & Anderson 2002; Anderson 2008). We used a natural average method to
 142 model-average parameters and error estimates. We calculated the 90% confidence interval (90% CI)
 143 and the odds ratio (OR) of the effects for each variable. We also estimated the relative importance (w_+)
 144 of a given variable, by summing the Akaike weights of all models containing the variable. A variable is
 145 considered as associated with the response variable, when its w_+ is larger than 0.7 and meanwhile, the
 146 90% CI excludes the zone value. All analyses were performed on R 3.0.0 (R Development Core Team,
 147 2013).

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149 Results

150 In total, we surveyed 12 villages in six townships (Fig. 1), and interviewed 100 residents with a mean
 151 age of 44 years. With regard to ethnic groups, half of the respondents were Tibetan and the other half
 152 were Han. The education level of respondents was low, with 36% illiterate and 44% having elementary
 153 education, while 20% being secondary and above. 

154 During the preceding three years, most (83.8%, 83/99) families of the respondents owned
 155 livestock, primarily yaks, which they grazed on alpine pastures, with an average annual number of 43
 156 (range 3-200, $n = 83$). Most of respondents of these families (79.5%, 66/83) reported that their

157 livestock suffered from depredation by wolves on pastures. The reported mortalities of livestock
158 depredation were high, with a mean annual rate of 24.8% (range 10%-30%, n = 66).

159 Most of the respondents (73%, 73/100) perceived the wolf population as increasing in the past
160 10 years, 23% (23/100) perceived it as decreasing and only 4% (4/100) perceived it as stable. The
161 majority of the respondents (84%, 84/100) were negative in their attitude to wolves, while 11% (11/100)
162 and 4% (4/100) of the respondents were positive and neutral towards wolves, respectively. One
163 respondent showed a mixed attitude. All people  who were negative towards wolves mentioned that
164 livestock loss caused by wolves was the main reason why they considered wolves a bad and 
165 detrimental animal. Therefore, they wanted to kill wolves and did not wish to protect wolves. Only
166 very few (3.6%, 3/84) people talked about fear of wolves, but  no one mentioned an event of wolves
167 attacking humans.

168 We constructed 32 candidate logistic regression models with five variables. As there were eight
169 models with $\Delta AIC_c < 2$, we used a model averaging approach to calculate estimates for variables. We
170 indicated that only the number of livestock owned was statistically related to attitudes of the
171 respondents towards wolves, as its relative importance was 0.92 and the 90% CI excluded the zero
172 value (Table 1). People with larger numbers of livestock  were more likely to be negative towards
173 wolves (Fig. 2). For each additional one livestock owned, people were on average 1.029 times more
174 likely to have a negative attitude towards wolves. The percentage of livestock depredated by wolves
175 and factors associated with personal characteristics (i.e. ethnicity, age, and education level) did not
176 predict variation of attitudes towards wolves.

177

178 Discussion

179 Understanding the perceptions of local people living adjacent to wildlife habitats of wildlife-human
180 interactions is important in the conservation of large carnivores, because they are apt to provide

181 reliable information about wildlife (Treves & Karanth 2003; Password & View 2005). However, it is
 182 difficult for the public to estimate wolf population sizes (Bjerke, Reitan & Kelle 1998). In this study,
 183 we instead asked local people's opinions about wolf population trends. Similar works have been
 184 previously conducted on other large carnivores, for example the Asiatic black bear (Liu et al. 2011).

185 Most of the people interviewed reported an increase in wolf populations in their areas in the
 186 preceding 10 years. Increase in abundance may reflect good protection and population recovery of the
 187 wolf in the wild since the prohibition of guns in 1996. This may have resulted in increased livestock
 188 depredation and human-wolf conflicts in recent years as reported by the local people. It is also possible
 189 that increase in human-wolf conflict it may also be a result of human encroachment on wolves' natural
 190 habitats (Naughton-Treves, Grossberg & Treves 2003) and ongoing degradation or loss of habitats
 191 (Yang 2008). In this case, wolves more frequently encounter and prey on livestock, while their natural
 192 prey populations reduce. However, it should be noted that livestock losses were self-reported in the
 193 interviews, and the reported magnitude of losses may differ from reality. It was hard to verify the
 194 magnitude of these reported losses in the present study, and thus we suggest that research efforts need
 195 to focus on this issue.

196 As reported by some previous studies (e.g., Ericsson & Heberlein 2003; Naughton-Treves,
 197 Grossberg & Treves 2003; Tuğ 2005; Røskaft et al. 2007), the local population had a negative attitude
 198 to wolves. The attitude formation towards wolves is strongly driven by physical and behavioral
 199 characteristics of wolves as well as by some cultural and historical associations such as human fear of
 200 wolves (Kleiven, Bjerke & Kaltenborn 2004; Bisi et al. 2007; Suryawati et al. 2013). In our study,
 201 the local people's explanation for negative attitudes was livestock loss that wolves incur, while very
 202 few talking about fear of wolves. Despite widespread fear of wolves, human fear of wolves may differ
 203 between areas and groups, because one is likely to be not afraid of wolves if having knowledge on



204 wolf's biology characteristics and awareness that wolves usually keep away from humans (Bisi et al.
205 2007; Yang 2008).

206 However, our finding, that variation of attitudes was not explained by personal characteristics,
207 is inconsistent with these studies in which people's attitudes towards wolves differed significantly
208 according to their age, education level and income. We found that Tibetan people were as negative as
209 Han people, and this was not expected, as Tibetan groups, being Buddhist, find it easier to accept the
210 protection of wildlife than Han people who have no dominant religion (Eckel 1998). A similar result
211 was also reported by Liu et al. (2011) in the study on human-bear conflicts of western Sichuan. It is
212 possible that increase in conflicts between wolves and the local villagers at our study site might have
213 resulted in negative public opinion. We suspect, though, that Tibetan people would be less likely to
214 attack wolves in revenge for livestock loss or engage in poaching, because of their belief that killing
215 wildlife could negatively affect their resurrection in the afterlife (Eckel 1998; Liu et al. 2011).

216 Little research has examined the potential links between attitude and variables concerning
217 livestock. In this study, we revealed that people with relatively large numbers of livestock were more
218 likely to have a negative attitude towards wolves than those with smaller numbers of livestock. To our
219 knowledge, there is no previous literature that has reported this phenomenon. In addition, we did not
220 find that people who had lost a larger percentage of their livestock to wolf depredation showed a more
221 negative attitude to wolves, as concluded by some previous studies concerning the wolf conflicts
222 (Williams, Ericsson & Heberlein 2002; Ericsson & Heberlein 2003; Naughton-Treves, Grossberg &
223 Treves 2003; Tuğ 2005). We acknowledge that assigning zero predation to informants who had no
224 livestock would artificially reduce the predation intensity, thus may have affected the relationship
225 between livestock losses and attitude toward wolves. Unfortunately, because of small samples, we
226 cannot further test the effect of percent loss using only those informants who had livestock.

227 As an explanation, we suggest that the current finding might be associated with the fact that the
 228 local people were impoverished and had seldom been compensated for their losses, while livestock
 229 mortality by wolves was a relatively common occurrence. It is expected that people who grazed a
 230 larger number of livestock and whose main source of income was from livestock, would be negative
 231 towards anything that may cause loss of their livestock and threaten their income. Even if wolves had
 232 not killed their livestock in the past, they would still have a negative attitude to wolves as they felt that
 233 no one could guarantee the safety of their livestock in the future. In contrast, people with a smaller
 234 number of livestock would expected to be neutral or positive in their attitude to wolves, as usually they
 235 were able to make much money from other sources and the economic benefits from livestock
 236 accounted only for a small part of their incomes.

237

238 Management implications

239 To mitigate future human-wolf conflicts, we must reduce livestock losses of local people who
 240 suffer from wolf depredation. In our study site and related areas, a large livestock group is herded
 241 commonly by a couple of people. The young today are not willing to take up this lifestyle. Meanwhile,
 242 the existing corral or fence structures are poorly built with low walls and no ceiling. Ineffective
 243 guarding of livestock might have aggregated depredation by wolves (Jackson 2000; Treves & Karanth
 244 2003; Li et al. 2013). Therefore, we suggest that the best approach at present should be to improve
 245 guarding of livestock in the context of local cultures and conditions, for example, increasing the
 246 number of herders, developing expertise in herding, and building wolf-proof corrals using local
 247 materials (see Namgail, Fox & Bhatnagar 2007).

248 Eco-compensation in mitigating human-wildlife conflicts has been increasingly emphasized by
 249 the government in recent several years (Xinhuanet 2014; Yunnan.cn 2014). Public education on wolf
 250 conservation has been conducting in our study site, but there have been no any provision of monetary

251 compensation for herders who lost livestock to wolves. The local forestry department mentioned many
 252 obstacles, such as the difficulty of verifying the magnitude of livestock losses reported by the local
 253 villagers. As an alternative approach, we could invest these monies in human resources and
 254 infrastructure, such as training herders and improving corrals. This will distribute the benefit equitably
 255 (Namgail, Fox & Bhatnagar 2007). Furthermore, initiation of the livestock insurance program guided
 256 by the government, a measure that has proved effective in the India's Trans-Himalayan region (Mishra
 257 et al. 2003), is encouraged for a long-term management.

258 There are other alternatives such as relocation or limited removal of problem wolves (e.g.,
 259 Mech & Boitani 2003; Treves & Karanth 2003; Bradley et al. 2005), and change of local livelihood
 260 (e.g., Jackson 2000; Conforti & de Azevedo 2003; Li et al. 2013). The local government is considering
 261 employing armed police to kill problem wolves. Although a reported increase in the wolf populations
 262 and in livestock depredation by wolves in our study site, causal relationships between them are not
 263 clear. In addition, there is no scientific information on wolf population sizes. Therefore, this measure
 264 will require further data on wolf population sizes and their relations with livestock depredation. The
 265 local government is also assisting herders to attempt to increase incomes from alternative sources, for
 266 example eco-tourism and the cultivation of economically important alpine plants, aiming to reduce
 267 their dependency on livestock. Two of the 12 villages we interviewed seemed to have been moving
 268 toward a more positive attitude toward wolves, to a more positive attitude. However, it should be noted
 269 that local people might be defiant toward the directions from authorities. Shift to other areas may also
 270 have different environmental impacts. The forms of income generation should be implemented and
 271 sustained selectively through existing institutions (Jackson 2000).

272

273 Conclusions

274 To conclude, this study investigated local villagers' perceptions of wolves in Jiuzhaigou County,
 275 western China. Local people reported an increase of wolf population and thus increased livestock
 276 depredation by wolves. People were generally negative towards wolves, despite a prevalent Tibetan
 277 culture that favors the protection of wildlife. These with a larger number of livestock were more likely
 278 to have a negative attitude towards wolves. In term of conservation management, we suggest that
 279 improved guarding of livestock and provision of monetary support on human resources and
 280 infrastructure may mitigate human-wolf conflicts in this region. Our study provides insights into
 281 management of human-wolf conflicts in western China.

282

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Table 1 (on next page)

Model-averaged coefficients and relative importance calculated for variables explaining variation in attitude of the respondents towards wolves

2

Variable	Estimate	Std. Error	z value	Lower 90%CI	Upper 90% CI	OR	w ₊
Intercept	0.122	1.087	0.111	-1.666	1.909	1.130	
ANL	0.029	0.017	1.678	0.001	0.057	1.029	0.92
Ethnicity_Han ^a	0.534	0.742	0.716	-0.687	1.756	1.706	0.51
APL	1.150	1.697	0.673	-1.641	3.940	3.158	0.50
Age	0.008	0.018	0.451	-0.021	0.037	1.008	0.35
Education ^b	0.012	0.099	0.120	-0.150	0.174	1.012	0.04
Education_ elementary school	0.078	0.315	0.245	-0.440	0.595	1.081	
Education_ secondary and above	0.053	0.340	0.155	-0.507	0.613	1.054	0.13



3 ^a “Tibetan” was set as the reference

4 ^b “Illiterate” was set as the reference

5 Abbreviations: ANL, annual number of livestock the respondent’s family grazed; APL, annual
6 percentage of livestock depredated by wolves.

7

1

Map showing the study area, Jiuzhaigou County, Sichuan Province, western China, as well as locations of villages investigated in the study

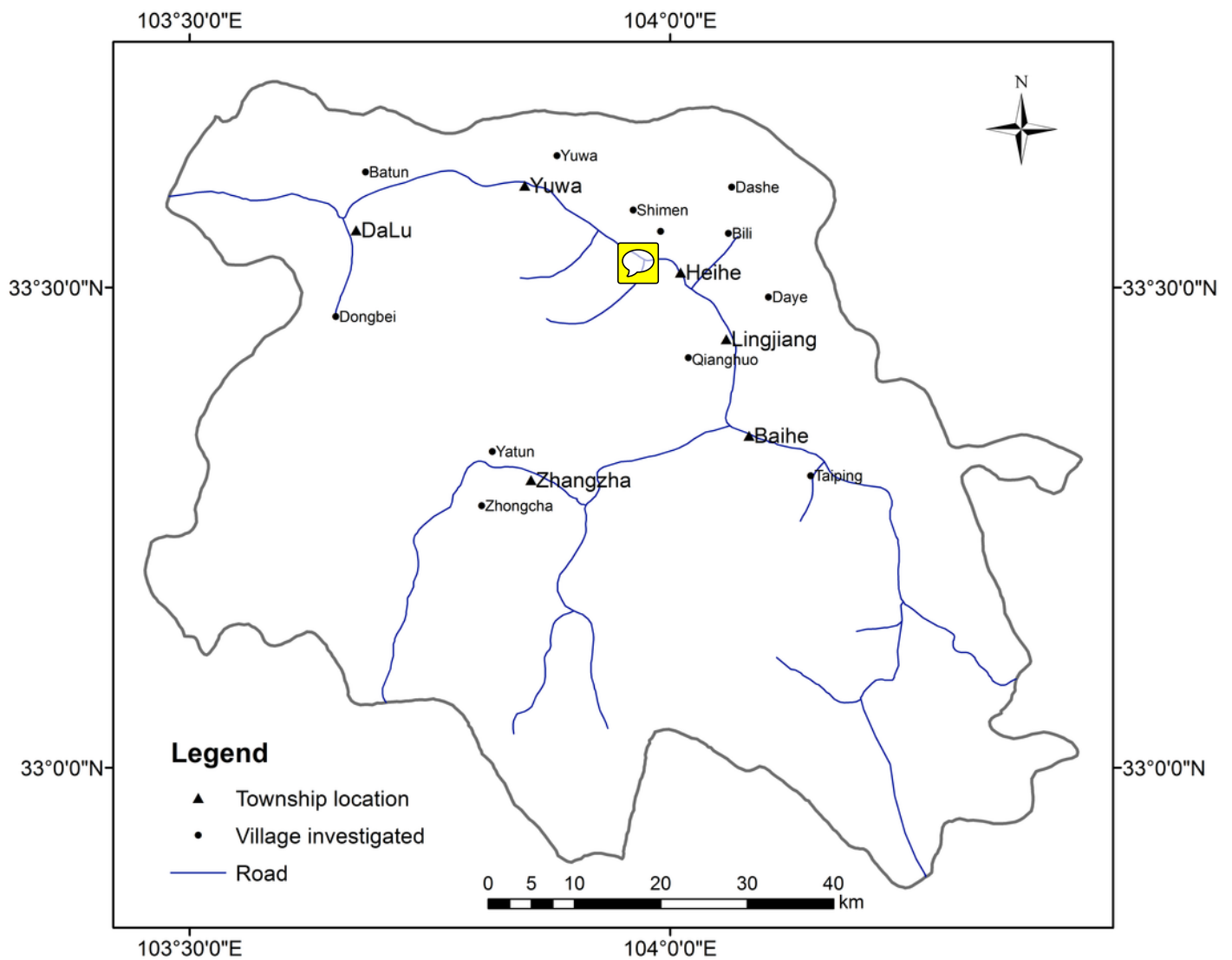
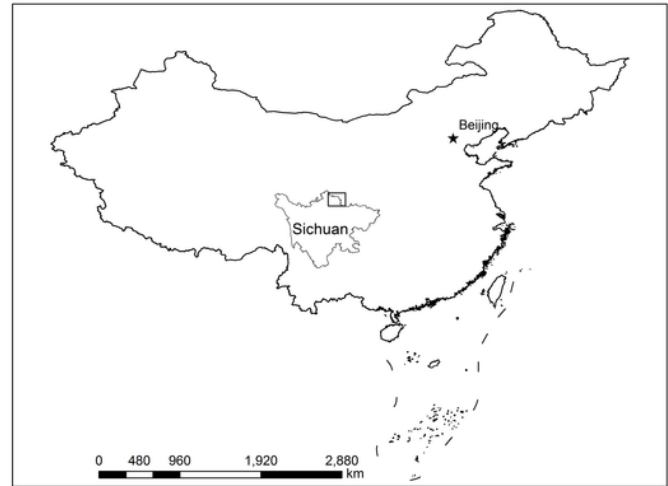


Figure 2(on next page)



Mean annual number of livestock grazed by families of respondents who had different attitudes towards wolves

