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## The role of saiga poaching in rural communities: Linkages between attitudes, socio-economic circumstances and behaviour

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### ABSTRACT

Effective conservation of exploited species requires an understanding of the motivations experienced by resource users. When use is illegal, it can be particularly difficult to distinguish users from non-users. The attitudes of local people are critical to conservation success, because they interact with social circumstances to determine behaviour. In this study we explore the factors influencing inferred poaching behaviour of the Critically Endangered saiga antelope (*Saiga tatarica*) in six communities in three countries of the former Soviet Union. We show that local people have a good understanding of the species' status and positive attitudes towards its conservation, regardless of their household's inferred poaching status. Poaching is a low prestige occupation, and our analyses suggest that it is carried out by poor, unemployed households who have the means to hunt. These results are consistent for all villages. However we find important regional differences in hunting behaviour, linked to saiga population density and migration patterns, which have implications for the likely effectiveness of different conservation strategies. Community-based interventions are more likely to be appropriate in Russia, where saigas are present year-round and hunting is more subsistence based, than in the strongly seasonal Kazakhstan populations where economies of scale require organised poaching by fewer households. This case study illustrates the complex linkages between attitudes, social circumstances and behaviour in resource user behaviour, and highlights both the consistencies and differences in drivers of poaching between locations at a range of spatial scales.

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### 1. Introduction

Worldwide one in four mammal species are considered threatened with extinction, and hunting is second only to habitat loss in driving this situation (IUCN, 2008). In order to reduce the threat of hunting it is important to understand the factors driving exploitation (Baillie et al., 2004; IUCN, 2008). Multiple socio-economic factors, including poverty, ownership conditions and access to alternative livelihood options, impact people's decision-making about natural resource use (Holmes, 2003; Adams et al., 2004).

Several studies suggest that in order to successfully implement community-based projects, local communities have to value the resource highly in order to be willing to actively manage it (Inamdar et al., 1999; Salafsky et al., 2001). But while positive attitudes towards conservation are argued to be essential for conservation success (Kiss, 2004), positive attitudes do not necessarily imply positive action in terms of changes in resource use behaviour (Ite, 1996; Alexander, 2000).

The Soviet Union was widely considered to have "one of the most effective biodiversity conservation programs in the world" owing to the vast area of protected areas and wilderness, coupled with strict law enforcement (Dinerstein et al., 1994). However, its centrally planned economy provided little incentive for sustainable resource use, since the majority of conservation schemes relied heavily on enforcement rather than on voluntary action of society. The political and economic transition that followed the collapse of the USSR in 1991 led to the breakdown of rural economies throughout the region. The resultant exploitation pressure on wild

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populations valuable for food and income was further exacerbated by the breakdown of central authority and the cessation of protection efforts, inside and outside of protected areas. For species valuable outside of the Soviet Union's territory the opening of international borders created access to global markets, facilitated trade and led to a further increase in harvesting pressure (Dinerstein et al., 1994). One species whose fate has been inextricably linked to these socio-political changes is the saiga antelope, *Saiga tatarica*. From the mid-1990s onwards saiga populations started to decline rapidly – the more accessible ones first, the more remote populations later. The decline, of more than 95% over 10 years, was so precipitate that the saiga jumped from Lower Risk (conservation dependent) in 1999 to Critically Endangered in 2001 on the IUCN Red List ([www.redlist.org](http://www.redlist.org); Milner-Gulland et al., 2001). Hunting is unequivocally accepted to be the primary reason for this population collapse (e.g. Milner-Gulland et al., 2001). It is generally believed that limited access to alternative livelihood options, lack of environmental education and poverty are the driving forces of saiga poaching (Milner-Gulland et al., 2001; Robinson and Milner-Gulland, 2003; CMS, 2006). However, this inference is based on anecdotal information, and there has been no research on the specific factors affecting saiga poaching, and how they vary between different saiga populations and range states.

In this paper we examine attitudes towards saigas, the role of poaching as a livelihood option in rural communities, the use of saiga products and factors predicting poaching behaviour. The study covers six locations in three countries (Russia, Kazakhstan and Uzbekistan), representing three saiga populations and a wide range of social and economic situations. The study is unusual in attempting to link attitudes directly to behaviour, a step which is rarely taken but is key in understanding the likely impact of conservation interventions on resource users (Holmes, 2003), and in comparing reported behaviour from two different sources – household interviews and key informants.

## 2. Methods

### 2.1. Study site

The study was conducted in 2003–2006 in six communities within the range of three saiga antelope populations; the north-western pre-Caspian region (Russian Federation), Ustiurt (Kazakhstan, Uzbekistan) and Betpak-dala (Kazakhstan) saiga populations (Milner-Gulland et al., 2001; Table 1). Study sites were chosen on the basis of their location within the saiga antelope range, reported saiga antelope poaching activity and size of the community (sufficiently small to permit representative sampling). At all the study sites, poaching incidents had been reported during the survey year, with the exception of Ulanbel village in Betpak-dala, where it was only known that poachers had been active in 1996–1998 (Robinson, 2000). In the pre-Caspian region interviews were not only conducted in two villages (Tavn-Gashun, Khulkhutta; Table 1), but also at isolated farms (Chernye Zemli farms; Table 1), as the neighbouring Protected Area rangers suspected these households to be involved in saiga poaching.

**Table 1**  
Number and percentage of households sampled using questionnaire-based semi-structured interviews, by survey site.

Country	Saiga population	Community	Households	# Sampled	% Sampled
Russia	Pre-Caspian	Tavn-Gashun	71	37	52
		Khulkhutta	120	61	51
		Chernye Zemli farms	27	22	81
Kazakhstan	Ustiurt	Bosoi	467	135	29
	Betpak-dala	Ulanbel	280	86	31
Uzbekistan	Ustiurt	Yaslyk	180	103	57
		Total	1145	444	39

### 2.2. Data collection

Methods used included Participatory Rural Appraisal (PRA), key informant interviews and household questionnaire surveys. The combined use of quantitative and qualitative research methods ensured a balance of depth and breadth of research (Bernard, 2002). Moreover, results from several independent sources of data were compared (triangulation) in order to address sensitive issues such as poaching and to obtain a higher certainty of the accuracy of the data (e.g. Duraiappah et al., 2005). Each village was surveyed for a minimum of 6 weeks by a team consisting of AK (replaced by EB and AE in Uzbekistan), a Kalmyk social scientist (NB) and one to three research assistants. No translators were used; interviews were conducted in the local language that the interviewee was most comfortable with. Each household was presented with a small gift as a reward for their effort and to acknowledge local custom. All interviews and focus groups were anonymous. A “bare-foot” strategy (eating and living with local people, moving on foot not with vehicles; Pretty et al., 1995; Kapila and Lyon, 2000) was used to facilitate familiarisation. Village meetings were organised at the beginning and conclusion of each survey.

### 2.3. Participatory Rural Appraisal

During the initial phase, village transects and mapping exercises were organised (Kapila and Lyon, 2000). Historical timeline exercises were carried out with individuals who the head of the village had recommended or were known to have lived in the village since its foundation (de Zeeuw and Wilbers, 2004). Focus groups were organised for livelihood activity, village income and wealth ranking PRA exercises, with 3–6 participants and lasting for up to 3 h. The focus group was asked to list and compare all the different livelihood options of the village. Categories for comparison were chosen (e.g. income obtained, physical difficulty, hours per day worked, education level required, opportunity to advance career) and each livelihood activity scored from 1 (lowest) to 5 (highest) for all categories. The overall popularity of each livelihood option was ranked. The focus group was then asked to identify and discuss the relative importance of all the sources of income contributing towards overall village income, including saiga poaching. Percentages were assigned to each contributing source. Household wealth comparisons were found to be inappropriate to a group situation (Kühl, 2008), so three willing participants per village were asked on a one-to-one basis to rank households' wealth towards the end of the survey. Relative importance of indicators of wealth was discussed (e.g. house type, ownership of vehicles and livestock). All households were listed and classified into three categories of household wealth; “relatively poor”, “average wealth”, “relatively rich”.

### 2.4. Key informant interviews

Towards the end of each village survey three individuals who had been open about saiga poaching activities were asked individually to list the households that were involved in regular saiga

poaching within the village. The three surveys were conducted independently and anonymously. Only households which appeared on all three lists, or in which a household member openly stated that the household poached, were taken to be poaching households. At one study site in the pre-Caspian (Chernye Zemli, Table 1) individual households were too dispersed, so there was no possibility to obtain triangulated data on poaching activities. This location was therefore excluded from analyses involving poaching activity. Whenever a poacher or ex-poacher was encountered who was prepared to discuss his or her saiga poaching activities, a series of anonymous in-depth interviews were conducted. The incentives to hunt over time, the livelihood situation of the relevant household, hunting methods, saiga offtake by month, meat and horn trade, experience of law enforcement, and profitability of their activities were discussed.

### 2.5. Household questionnaire surveys

A questionnaire-based household survey was used to collect quantitative data. Households were selected randomly from the complete list of households produced during the village transect (Table 1). The unit of response for the questionnaire focussed on livelihoods was the household, which was defined as all the people who “share a cooking pot” (Kapila and Lyon, 2000). Any member of the household above the age of 16 was permitted to take part in the livelihood questionnaire survey focussing on the entire household. Often a group of household members participated in the livelihood questionnaire survey. A second questionnaire focussed on the attitudes of the individual and was only administered to one person per household. Both questionnaires were conducted within the same household. Interviews were semi-structured and informal, conducted by two members of the research team per household (Bernard, 2002); each questionnaire took between 20 min and 2 h to complete.

The livelihood questionnaire was designed to investigate household demography, livelihood activities and sources of income at the time of the survey and prior to 1991, ownership of livestock and vehicles, meat consumption and purchasing power, access to information and village development. The attitude questionnaire was designed to investigate awareness of saiga presence and seasonal movements, awareness of changes in saiga population ecology since 1991, reasons for potential changes in saiga population, trade in saiga horn and meat, awareness of seasonal and daily trends in poaching activity, and attitudes towards saigas and their conservation.

### 2.6. Statistical analysis

Factors influencing poaching involvement of individual households were assessed using generalised linear mixed-effects models (LMER) using binomial error structure to test for the following factors, after the graphical exploration of possible non-linearity of covariates using additive models (Hastie and Tibshirani, 1990): effects of wealth, employment status, number and type of livestock ownership, vehicle ownership, length of residency within the village, household size, primary ethnicity of household, primary source of income, livelihood activities practised by the household members, household head characteristics (education, age, ethnicity, social status), monthly meat budget and consumption. Relative wealth of households (estimated using PRA ranking) was strongly positively correlated with relative monetary income (estimated from quantitative questionnaire data; ANOVA:  $F_{2,335} = 14.102$ ,  $p < 0.001$ ). However, monetary income was not available for all villages, hence PRA wealth was used in the analysis. Individual-specific variables within the attitude questionnaire (e.g. sex and age) were not tested since poaching status could only be established

at the household level. Preliminary importance of explanatory factors was assessed using tree models (library tree, R) and contingency tables. Households were nested within village, by fitting village as a random factor within mixed effects models. The significance of explanatory factors and their interactions (if relevant) in the mixed effects models were assessed using stepwise backwards regressing using Akaike Information Criterion (AIC) from the full model (Crawley, 2007). Standard diagnostic tools for normality, heteroskedasticity and influential values (Cook's D) were used to assess model fit (resulting in  $p < 0.05$  in all cases).

Proportions of successes and failures of categorical data were compared between individual groups with “prop.test”, a type of chi-squared test for two-level proportion comparison within R (Crawley, 2007). To avoid potential effects due to differences in sample size, cell frequencies were standardised when appropriate (sample size permitting) prior to performing chi-squared tests. Fisher exact tests were performed where required (Crawley, 1993). All probability values are two-tailed. Means are reported with their standard errors in the form means (s.e.). All analyses were conducted in R v. 2.5.1 (R Development Core Team, 2007).

## 3. Results

### 3.1. Awareness of and attitudes towards saiga population declines

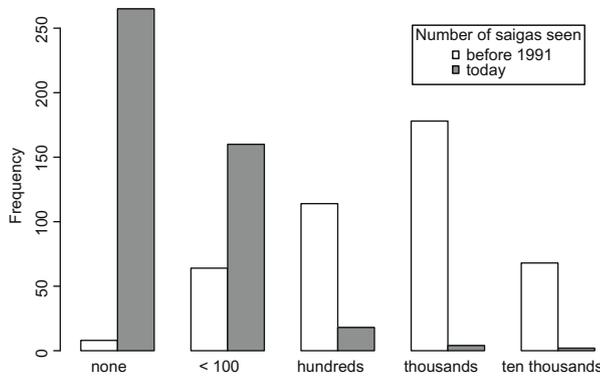
Across all study sites, the vast majority of individuals interviewed were aware of the decline in saiga numbers (95%,  $n = 456$ ; Table 2). Respondents had encountered saigas and calving aggregations significantly less often within the twelve months leading up to the survey compared to 1991. In the pre-Caspian region 45% ( $n = 131$ ) people stated that the number of males within the saiga population had declined. In the remaining regions, by contrast, only 8% ( $n = 325$ ) reported this change. The size of the herds seen had also decreased dramatically (Fig. 1). The decline in saiga numbers was attributed primarily to poaching by the majority of respondents (89%,  $n = 437$ ), irrespective of whether the respondent's household was involved in saiga poaching. Other contributing factors mentioned were climatic effects (7%), predators (1%), anthropological factors such as vehicle disturbance (2%), biological factors such as diseases (1%), and exploitation by rangers and police (1%).

Local people were aware of saiga presence in the vicinity of their village, and the seasonal variation of local saiga abundance. The results correspond well with the saigas' known migratory movement between winter, breeding and summer pastures, and the location of the respective communities along the migratory route. Those villages located close to the saiga's calving grounds experience a relatively high presence of saiga in May (Khulkhutta, Bosoi), whereas those located in the winter habitat (Ulanbel, Yaslyk) display the highest awareness of saiga presence in winter. Seasonal trends in saiga poaching activity reflect both saiga presence and a peak in activity in September–November. 85% of respondents confirmed that autumn is the main hunting season because during this time saiga meat quality is best and fat content highest

**Table 2**

Percentage of respondents who had seen saigas or encountered a birth aggregation in 1991 and during the 12 months prior to the survey (results from attitude survey).

Village	Sightings (any)		Calving aggregation		n
	1991 (%)	Current (%)	1991 (%)	Current (%)	
Khulkhutta	100	48	88	32	58
Ulanbel	99	11	9	5	87
Bosoi	95	18	65	7	132
Yaslyk	90	37	26	10	104



**Fig. 1.** Changes in saiga numbers encountered by the local population. Respondents were asked what the largest number of saigas was that they could see at any one point in time in one location in the year 1991 ( $n = 432$ ) and in the last twelve months (2003–2005;  $n = 449$ ). The difference between the two samples is highly significant ( $\chi^2 = 581.37$ ,  $df = 4$ ,  $p < 0.001$ ).

( $n = 98$ ; no difference between villages:  $\chi^2 = 0.28$ ,  $df = 3$ ,  $p = 0.963$ ). Other reasons included that saiga are aggregated at this time, the meat is easier to conserve in the cold and that the soil is generally still hard and not covered by snow, allowing hunting by motorbike.

In all survey sites, the great majority of respondents stated that they would mind if saiga antelopes went extinct (93%,  $n = 462$ ). There was no difference between poaching and other households ( $\chi^2 = 0.06$ ,  $df = 1$ ,  $p = 0.809$ ). 82% of respondents wanted to take action (e.g. patrolling, awareness raising) to help conserve their local saiga population (no difference between poaching and other households:  $\chi^2 = 0.35$ ,  $df = 1$ ,  $p = 0.556$ ;  $n = 462$ ). Many even wanted to do so for free (41%,  $n = 243$ ); however, significantly fewer poaching households were prepared to do this (20%;  $\chi^2 = 6.21$ ,  $df = 1$ ,  $p = 0.013$ ). Almost 50% of respondents would like further information about saiga conservation ( $n = 387$ ); poaching household members requested extra information significantly less often, but still 35% of the time ( $\chi^2 = 4.07$ ,  $df = 1$ ,  $p = 0.044$ ).

### 3.2. Saiga poaching as a livelihood activity

Poaching was not a common livelihood activity in 2003–2006; generally only a small proportion of a village was involved on a regular basis. Informant interviews suggested that in the pre-Caspian and Ustiurt a minimum of 4–32% of households were actively engaged in saiga poaching, while in Ulanbel regular poaching activity had ceased (Table 3). This pattern was confirmed by questionnaire responses; more than 75% of respondents stated that poaching activity was ongoing in their villages (pre-Caspian: 97–

100%), whereas in Ulanbel only 6% stated that this was the case ( $n = 315$ ). Poaching activity was a sensitive subject; estimates of involvement from questionnaire respondents tended to be more conservative than those from key informants (Table 3).

Saiga poaching plays a relatively minor role in both overall village and individual household income. PRA focus groups estimated that only 6.75% of village income is derived from the sale of saiga produce (SE: 1.73,  $n = 12$ ; Table 4). At the household level, only 4% of total households and 16% of poaching households stated that their primary source of income was derived from hunting or fishing ( $n = 335$ ;  $n = 55$ ).

Saiga hunting was the second-least popular livelihood activity after housework, consistently across all villages (Fig. 2). On a scale of 1 (lowest) to 5 (highest), the potential for future career progress was felt to be low ( $1.54 \pm 0.97$ ), income obtained was average ( $2.85 \pm 0.23$ ) and poaching was physically demanding ( $4.27 \pm 0.15$ ;  $n = 13$  for all results). Moreover, accidents were frequent, hence saiga poaching was seen as a male activity; women are only involved in meat processing and sale (e.g. in Khulkhutta). The illegality of saiga poaching was another deterrent; 97% of respondents were aware that saiga hunting was illegal (there was no significant difference between villages:  $\chi^2 = 0.52$ ,  $df = 5$ ,  $p = 0.991$ ). Awareness of saiga management activity such as ranger patrols was high, varying from 69% in Bosoi to 100% in Khulkhutta ( $n = 373$ ).

### 3.3. Use of saiga produce

Most saiga hunting was reportedly aimed towards the sale of horns rather than the sale of meat or subsistence provision (Fig. 3). Males are more than twice as valuable as a saiga female due to the sexual dimorphism of the species, but primarily because of the horn (assuming that the average horn weighs 125 g; Li et al., 2007). Almost all horns were reportedly sold for export. In Ustiurt, poachers sometimes kept horn trophies as talismans. One household in Khulkhutta used saiga horn as a medical treatment.

However, meat was also actively traded within villages; 90% of local people interviewed confirmed this ( $n = 318$ ). While meat prices were highest in Bosoi, the ratio of meat to horn prices was highest in Yaslyk, and also relatively high in the pre-Caspian (Table 5). Numerous respondents suggested that meat demand had increased in the last few years. In the pre-Caspian, saiga meat was referred to as “the meat of the poor” who could not afford more expensive meat from domestic animals; this was a long-standing view, dating back to Soviet times (key informant, Tavn-Gashun village).

In Bosoi, an exceptionally organised group of nine regular poachers was interviewed, who estimated that at least two-thirds

**Table 3**  
Percentage of individual households involved in saiga poaching and related activities (e.g. trading saiga meat; lumped under “other involvement”) by survey location ( $n = 424$ ). The number of households involved in poaching is shown as a minimum estimate from key informants, and separately below as estimated from household questionnaire interviews. Individual farms surveyed in the Chernye Zemli area ( $n = 22$ ) have been excluded since response triangulation to determine household status was not feasible. The proportion of households engaged in saiga poaching (estimated from key informants) varied significantly between study villages in the pre-Caspian, Kazakhstan and Uzbekistan ( $\chi^2 = 22.26$ ,  $df = 3$ ,  $p < 0.001$ ). In the household interviews, a larger proportion of households was stated to be involved in poaching in Tavn-Gashun than in Bosoi ( $t_{3,170} = 2.53$ ,  $p = 0.012$ ); there were no significant differences between the other villages.

Involvement from informant interviews	Pre-Caspian		Kazakhstan		Uzbekistan
	Tavn-Gashun	Khulkhutta	Bosoi	Ulanbel	Yaslyk
Not involved + NA	65%	83%	96%	78%	83%
Poacher	32%	7%	4%	0%	17%
Other involvement	0%	10%	0%	0%	0%
Ex-poacher	3%	0%	0%	22%	0%
Total sample ( $n$ )	37	63	134	87	103
Poachers (household interviews)	14%	10%	6%	0%	9%
Total sample ( $n$ )	29	34	54	50	56

**Table 4**

Percentage of total village income derived from individual sources (mean  $\pm$  SE; output from PRA focus groups conducted in survey villages). There were no significant differences in the extent to which saiga poaching contributed between villages:  $\chi^2 = 5.84$ ,  $df = 3$ ,  $p < 0.120$ .

Village	Private livestock	State salaries	State pensions	Private sector	Saiga poaching
Tavn-Gashun	49 $\pm$ 5	25 $\pm$ 3	16 $\pm$ 1	5 $\pm$ 0.3	5 $\pm$ 4
Khulkhutta	51 $\pm$ 4	13 $\pm$ 1	10 $\pm$ 1	16 $\pm$ 1	10 $\pm$ 2
Ulanbel	32 $\pm$ 2	24 $\pm$ 6	29 $\pm$ 2	16 $\pm$ 6	0
Bosoi	15 $\pm$ 3	13 $\pm$ 2	14 $\pm$ 1	54 $\pm$ 2	3 $\pm$ 1
Yaslyk	13 $\pm$ 4	32 $\pm$ 4	32 $\pm$ 4	13 $\pm$ 3	10 $\pm$ 5

of their household income was derived from wildlife poaching. All the group members were unemployed, receiving approximately 10,000 KZT (~74 USD) monthly from state support. Unlike other more subsistence-based hunters, who went on short hunting trips (<24 h), this group organised hunting trips that lasted 3–4 days to ensure that a sufficient number of saigas was encountered. The group aimed to make a profit of 150,000 KZT (~1107 USD) per hunting trip and actively hunted saigas throughout the year, weather and saiga presence permitting. Approximately two such hunting trips per month were required to ensure that all members of the group had a minimum monthly income of 30,000 KZT (~221 USD). In summer 2005, at least 50–60 saigas (60–70% adult females) were reported killed per hunting trip to reach the profit tar-

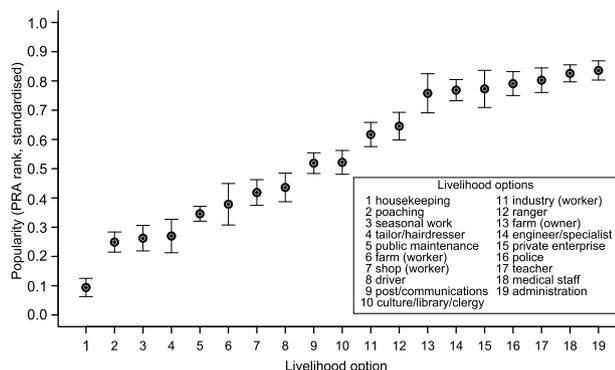
get, with an estimated annual offtake of around 1000–1200 saigas assuming a 10-month hunting season and two hunting trips per month. Horns only contributed 18–20% of the gross income from this hunting, with the rest coming from meat sales. For 1 or 2 months in the winter, when the saigas had migrated south into Uzbekistan, the group switched to hunting wild boar and supplied the commercial meat market (focusing on ethnic Russians, rather than the Muslim Kazakh community). It is likely that in all the survey communities the sale of meat contributed more towards overall poaching income than horns, since horn and meat prices showed similar differences across survey sites (Table 5).

### 3.4. Characteristics of poaching households

Of the large range of factors analysed for their potential in explaining variation in household poaching involvement, three were found to be significant consistently across all villages: relative wealth, employment status and number of motorbikes owned (Table 6). Households within the poorest wealth category were more likely to be involved in saiga poaching activity (Table 6; line 2). If the household head was unemployed, households were also more likely to engage in saiga poaching (Table 6, line 4). Finally, motorcycle ownership was positively correlated with poaching involvement (Table 6, line 5).

These results were confirmed by responses to the question “Why do people engage in saiga poaching?” in the household survey. Seventy five percent stated that unemployment was the primary factor driving saiga exploitation, next to foreign demand for saiga horn (23%). Local demand for saiga meat was generally listed as the secondary reason (25% of secondary responses). In Bosoi, however, 50% of the respondents listed demand for meat as the secondary reason ( $n = 132$ ).

It was not possible to assess quantitatively whether previous poaching activity had improved an individual household's socio-economic situation, although there was some anecdotal evidence.



**Fig. 2.** Overall popularity of livelihood options available across all study sites determined during PRA livelihood matrix focus groups ( $n = 16$ ). Ranks were standardised per village (mean  $\pm$  SE plotted for all villages combined) and only livelihood activities pursued across all study villages are displayed (with the exception of poaching, which was not actively practised in Ulanbel). “Public maintenance” livelihood activities include a range of low paid state jobs such as cleaners, heaters and security personnel for public institutions. “Specialist” is a general term of Soviet origin for highly educated state employed individuals such as agronomists or statisticians.



**Fig. 3.** Responses to the question “Out of all the saigas poached in this village, what percentage is hunted primarily to sell the horn, the meat or for subsistence use?” posed during the questionnaire survey ( $n = 313$ ).

**Table 5**

Prices of horn and meat for each of the survey sites in the local currency (RUB: Russian Rubles, KZT: Kazakh Tenge, UZS: Uzbek Sum) and in US dollars (converted using the exchange rate valid at the time of the survey). Ulanbel was not included since no trade in saiga produce was reported during the survey in 2004.

Village	Price of meat (per animal)		Price of horns (kg)	
	Mean $\pm$ SE currency	USD	Mean $\pm$ SE currency	USD
Chernye Zemli Farms	312 $\pm$ 25 RUB ( $n = 12$ )	10.33	1868 $\pm$ 84 RUB ( $n = 11$ )	61.85
Tavn-Gashun	306 $\pm$ 18 RUB ( $n = 32$ )	10.13	1918 $\pm$ 180 RUB ( $n = 20$ )	63.51
Khulkhutta	306 $\pm$ 5 RUB ( $n = 46$ )	10.22	2222 $\pm$ 85 RUB ( $n = 30$ )	74.19
Bosoi	2706 $\pm$ 69 KZT ( $n = 86$ )	19.97	11,975 $\pm$ 1153 KZT ( $n = 20$ )	88.38
Yaslyk	19,355 $\pm$ 297 UZS ( $n = 73$ )	19.36 <sup>a</sup>	52,692 $\pm$ 4857 UZS ( $n = 13$ )	52.69

<sup>a</sup> Unlike the other survey sites, in Yaslyk, saiga meat is generally sold per kg (1173  $\pm$  27 Sum  $\approx$  1.17 dollar,  $n = 73$ ; average gutted saiga weighs 15–18 kg, price in USD: 17.60–21.11 per saiga) rather than by the whole animal.

**Table 6**

Generalized linear mixed-effects model of predictors of household involvement in saiga poaching (with involvement as a binary response variable), 2003–2005 ( $n = 333$ ). Location (four villages: Tavn-Gashun, Khulkhutta, Bosoi, and Yaslyk) is included as a random effect; the baseline relative wealth is “average”, the baseline employment status is “employed”. The direction of the effect can be determined from the sign of the coefficients. Interactions between the variables were not significant. Ulanbel was excluded because regular poaching of saigas within the Betpak-dala population had stopped at the time of the survey (2004); the Chernye Zemli farms were not included because poaching involvement of individual households could not be established.

Parameters	Estimate	SE	z-Value	p-Value
Intercept	-2.871	0.502	-5.722	<0.001
Relative wealth (poor)	0.978	0.395	2.476	0.013
Relative wealth (rich)	-0.591	0.543	-1.089	0.276
Employment status (unemployed)	1.163	0.375	3.098	0.002
Number of motorbikes owned	1.138	0.315	3.614	<0.001

Ulanbel, the village in which poaching no longer takes place, experienced high emigration rates from the early 1990s until approximately 2004. Some households which profited from the sale of saiga horn in the early 1990s could afford to send their families to town and subsequently moved away (EJMG pers obs; Milner-Gulland and Kühn, 2006).

#### 4. Discussion

This study suggests that the exploitation of saiga antelopes is directly linked to poverty and unemployment, but that there is no association between attitudes and poaching involvement. In fact, poaching activity takes place despite local people expressing considerable concern for the species and the vast majority being prepared to actively contribute towards its conservation. These findings support an increasing number of studies suggesting that positive attitudes towards a resource are not necessarily linked to positive conservation action (Ite, 1996; Alexander, 2000). The results presented confirm the notion that poor people should not be expected to refrain from exploiting a knowingly decimated population of saigas and act like “ecologically noble savages” when the need for income is immediate (Alvard, 1993).

Levels of awareness of saiga ecology and population declines were remarkably high throughout all regions surveyed. This is surprising since all parts of society were interviewed, including elderly people and women, whose household chores restrict their ability to go out to the steppe. Local people had obtained some knowledge of the plight of saiga populations from the mass media, but most knowledge had been obtained locally as indicated by the regional differences in the data on seasonal saiga sightings and saiga calving, which correlated very well with saiga migratory behaviour and the position of villages along migratory routes. Local people valued saigas highly, partly because they are viewed as a flagship species of the steppe resonating closely with the nomadic history of many of the resident ethnic groups, but also because of their perceived importance for the ecosystem. However, the need for income and food appears to override these positive attitudes, at least within particularly poor households. While members of poaching households valued saiga just as highly as other local people, they were less willing to contribute towards saiga conservation without monetary reimbursement.

Saiga poaching was a very unpopular livelihood activity because it is physically demanding, risky and a livelihood activity that is neither particularly lucrative any more, given low saiga numbers, nor provides good career prospects. Moreover, the illegality and risk of punishment involved may have contributed to the negative image of poaching. At both the village and household level, poaching made only a small contribution to overall income. Compared to

other livelihood activities, it rarely provided the primary source of income for households, and it was not a widespread practice. Even for poaching households, state support payments and wages made a much larger contribution to household incomes than hunting and fishing. However, a relatively small number of households regularly hunted saigas, with predisposing factors being that the household was relatively poor, the household head was unemployed and the household had access to a motorbike (which is required for saiga hunting). Throughout the world, rural poverty and resource exploitation are often tightly linked (Mainka and Trivedi, 2002). The saiga antelope is no exception to this general paradigm.

There were, however, two telling exceptions to this finding. In Ulanbel, Kazakhstan (Betpak-dala saiga population), saiga densities have reportedly been so low since 2002 that people no longer bother to poach there, unlike in the 1990s when poaching was rife. Ex-poachers reported that in 2004 local poachers travelled several hundred kilometres to the Ustiurt region, where population densities were higher, in order to hunt saigas. By contrast, in Bosoi, Kazakhstan (Ustiurt population), where until very recently saiga populations had been relatively high, a small group of organised poachers made a good living from commercial saiga hunting.

The relatively low profitability of saiga exploitation in most villages is likely to be linked to the current very low density of saiga populations. At high population sizes in the 1960s in the pre-Caspian, a group of 12–15 men were capable of culling 10,000–12,000 saigas within three months as part of the USSR saiga management regime (Bannikow, 1963). The costs of finding saigas have reportedly increased considerably since the 1990s due to the decline in saigas and their vast migratory range, especially in Betpak-dala and Ustiurt. Moreover, some poachers stated that the migratory routes had become less predictable, mass migration herds smaller and that smaller herds were more difficult to spot. The extent to which economies of scale affect the profitability of saiga poaching varies between populations. The migratory range of the pre-Caspian saiga population is smaller than that of Ustiurt and Betpak-dala. Moreover, saigas are present within the Chernye Zemli area in the pre-Caspian throughout the year and population density is higher, albeit with seasonal variations. As a result one motorbike is often sufficient to hunt in the pre-Caspian. In contrast, in Bosoi, Ustiurt, a combination of cars and motorbikes is used to ensure the profitability of hunting, on organised expeditions lasting several days. This method was effective enough that in 2005, nine men were able to kill at least 1000 saigas annually, which is 6–7% of the officially estimated average 2001–2006 population size (CMS, 2006). There is a risk that horn prices may increase disproportionately if saigas continue to decline, due to the rarity value of the product, a phenomenon termed the “Anthropogenic Allee Effect” (Courchamp et al., 2006; Hall et al., 2008). This may offset higher poaching costs and hence fuel further exploitation. Saiga poaching appeared to have stopped in the winter range of the Betpak-dala population when Ulanbel village was surveyed – this may suggest that demand for saiga horn is not reacting sufficiently fast to drive further poaching. However isolated poaching incidents are still being recorded throughout the study area, including in Betpak-dala (Saiga News, 2009).

Poachers aim to kill saiga males rather than females because they bear horns and have a higher body mass (Kühn et al., 2007). Without accounting for differences in body mass, the income derived from a saiga male is twice as high as that obtained from a female. However, due to the highly skewed sex ratio in all saiga populations (Milner-Gulland et al., 2003), the number of males that poachers can harvest is severely limited. Unlike in the 1990s when the carcasses of saiga males were frequently left behind and only the horns taken by the poachers (A. Khludnev, Y.A. Grachev, pers. comm.), the results presented here suggest that the value of saiga meat should not be underestimated. The relative prices and

availability of horns and meat in all study communities are such that the majority of income (up to 80% in Bosoi) is likely to be derived from meat, even if hunters' primary motivation is horns. Any intervention aimed at reducing saiga overexploitation needs to address not only the illegal trade in saiga horn, but also the local and regional trade in saiga meat. Saiga meat is still openly on sale in Khulkhutta village (pre-Caspian), for example (Saiga News, 2009).

It is common for people to be less willing to openly discuss matters of illegal nature. In the case of saiga poaching this was particularly evident from the fact that fewer people answered the more sensitive questions. Information relating to saiga poaching such as the trade in horn is not discussed openly, in fact many local people, especially women and elderly people, have a relatively poor understanding of the current horn market situation. In addition, it is likely that interview respondents concealed information out of fear of prosecution. However, the fact that interviews were anonymous and that sometimes only the local research assistants knew who the poachers were, protected respondents. Furthermore, the large sample and triangulation of results (through qualitative and quantitative interviews, observations and information from law enforcement personnel), as well as the comparison between villages, assisted in verifying the results. Importantly, the analysis showing that poaching is closely linked to poverty and unemployment is based on non-sensitive household statistics and the knowledge of which households were involved in poaching, which was independently assessed and did not require a response from the majority of households surveyed.

The results of this study and others (e.g. Martinez and Scicchitano, 1998; Holmes, 2003) indicate that the link between attitudes and behaviour is complex. With regards to saiga, it is evident that any conservation initiative that aims to reduce poaching needs to address the socio-economic situation in rural villages within the saiga's range. Specifically, unemployment and poverty need to be attended to. Many villages of the former Soviet Union have very few livelihood alternatives due to their remote location. However, there are relatively few settlements in saiga range areas, and the number of households depending on saiga poaching for income and food is likely to be low. Action needs to be targeted to these few households; the example of Bosoi illustrates that a single small group of hunters can have a considerable impact. It is also important that action should be case-specific. The villages in this study range from those practising predominately small-scale subsistence hunting (pre-Caspian) to commercial hunters (Bosoi) and post-hunters (Ulanbel). The persistence of particular types of hunting also depends on saiga migratory behaviour and range size. In Ustiurt, unlike in the pre-Caspian, the species range is large with approximately 1000 km in between summer and winter pastures and there is a strong seasonality to saiga presence. The effort required to locate and hunt saiga is considerable, which impacts on the economies of scale that are associated with poaching. In Ustiurt, several cars which could be loaded with motorbikes were frequently used for organised commercial poaching. Fewer people are able to overcome such barriers to entry, but are likely to make a larger profit once they do due to greater efficiency of hunting methods. Similarly efficient hunting methods have been reported in cases of saiga sport hunting by wealthy and well equipped expeditions (e.g. Klebelsberg, 2009).

Conservation interventions should adapt to the range of situations described. It appears that where the saiga's migratory range is smaller, and there are relatively low economic barriers to engaging in poaching, a larger number of households can hunt and rely on saigas for food and income at a low level (e.g. in the pre-Caspian). Under such circumstances, community-based interventions are likely to be important since they have a wide outreach and resultant initiatives are likely to be able to meet the opportunity costs of not poaching. In contrast, if only a very small number of

households engage in poaching, community-based initiatives may have difficulty in influencing these few households that are making relatively high incomes from poaching. Moreover, the profitability of this larger-scale exploitation is likely to be more substantial and incentives to stop poaching need to be considerably higher under such conditions. Hence in Ustiurt, a stronger emphasis on law enforcement may be required. In Betpak-dala, by contrast, there is a need for vigilance so that any increase in the saiga population past the economically viable density does not trigger renewed poaching. These findings are relevant to other migratory species that are heavily exploited and may inspire further studies into the effect of range size and migratory behaviour on exploitation patterns and the best avenues to pursue for conservation. Furthermore, the methodology applied in this study may be valuable for socio-economic research on other ecological issues in the ex-Soviet Union and elsewhere.

In conclusion, this study has shown that saiga exploitation is directly linked to unemployment and poverty, which drastically increased after the collapse of rural economies within the saiga's range. While positive attitudes towards saiga are likely to be beneficial for conservation interventions, the results illustrate that if needs for income and food are immediate these positive attitudes are overruled. However, it would be too simplistic to expect that poachers will turn into conservationists if poverty and unemployment are addressed. The poverty in rural areas of the saiga's range is extensive and communities such as Bosoi are often divided. This study demonstrates that national and international conservation policy needs to take into account regional differences in the factors that are linked to saiga exploitation. The fact that saiga poaching is not widespread and is an unpopular profession does however provide an optimistic starting point. Given the Soviet background and the fact that law enforcement is still culturally the norm in the region, law enforcement initiatives should be improved. However, until the socio-economic forces driving saiga exploitation are addressed, saiga poaching is likely to continue at an unsustainable level.

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