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Research report

Grey wolf in Gilgit-Baltistan, Pakistan: distribution, abundance and persecution

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Abstract

Questionnaire analysis and confirmatory field survey carried out in 2006 suggested 350-400 grey wolves *Canis lupus* distributed over some 35,000km^2 of Gilgit-Baltistan, Pakistan, occurring at a density of 1.0-1.4/100km^2 and distributed at similar density in all vegetation types. Group size ranged between one and six, with the majority of sightings (n = 185) consisting of lone wolves (55%) or pairs (18%). Average pack size decreased from 7.0 ± 3.0 (n = 13) prior to 1991 to 2.0 ± 0.33 (n= 21) by 2006, suggesting a decreased availability of large prey. Litter size ranged between one and nine (average 3.2 ± 0.29 young/ litter) with modal numbers of 2 (31%) and 3 (31%). Some 66-87 wolves were killed during 2005-2006, mostly in winter using firearms, and in retaliation to attacks on livestock. Generally, residents reported little fear of wolves, and there were no reported cases of recent wolf attacks on humans. Wolf pelts were available for Rs. 100-10,000 (US$ 1.5-150) in several markets.

Introduction

The grey wolf *Canis lupus* was historically well-distributed throughout the Palearctic and Nearctic biogeographic realms (Vila et al. 2002, Mech and Boitani 2010) but has seen its global range reduced by 33% during the last century (Mech and Boitani 2010). It is actively persecuted because of livestock depredation and fear for personal safety (Mech and Boitani 2010). Lydekker (1907) identified two wolf subspecies in Pakistan, the Tibetan wolf *Canis lupus chanco* (Hodgson) occupying portions of the Himalayas, and the Indian wolf *C. l. pallipes* (Sykes) occupying the southern regions from the Kashmir valley. Recent molecular phylogenetic studies suggest that the wolf lineages of the Indian subcontinent may undergo significant taxonomic revision (Sharma et al. 2004, Aggarwal et al. 2007). Our study concerns the grey wolf *sensu lato* in Pakistan.

To date, research on the grey wolf in Pakistan has been very limited. While the global population is estimated at 150,000 (Route and Aylsworth 1999), Mech and Boitani (2003) estimated that just 200 wolves remained in Pakistan. The range of the grey wolf extends from the southern mountains of Balochistan to the northern border, i.e. Chitral, Gilgit and Baltistan (Roberts 1997), inhabiting tropical thorn forest, tropical dry scrubland, sub-tropical scrubland and hot desert. Wolf populations have experienced both numerical declines and a 80-90% range contraction in Pakistan (Mech and Boitani 2003, Sheikh and Malour 2005). Location-specific population estimates do not exist. All *C. lupus* populations from Bhutan, India, Nepal and Pakistan are protected under Appendix I of CITES.

Gilgit-Baltistan (GB) represents a scientific frontier for ecologists, as there is very little information on the distribution and biology of any wild species including the grey wolf (Sheikh and Molur 2005). Roberts (1997) reported wolves from three localities of GB; Karabos, Bubind and Sadpara. Rasool (1998) suggested a wide distribution of wolves in GB, but did not comment on population levels. Here, we document the status of the grey wolf in GB. Our specific objectives are to: (a) identify the species geographic distribution, (b) estimate population size, (c) determine past and present pack sizes, (d) estimate litter size as an indicator of recruitment, (e) gauge the level of wolf persecution, and (f) determine whether wolf body parts are entering the wildlife trade. To meet these objectives, we combined the

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use of field-based population surveys and questionnaires to incorporate local expertise. There is a growing trend of incorporating traditional ecological knowledge into conservation research, because local people often have acquired knowledge and insights through their extensive use and observation of particular areas or species (Huntington 2000).

Methods

Study area

Gilgit-Balistan Province (GB) (formerly Federally Administered Northern Areas of Pakistan) encompasses 72,971km^2 and lies at 71-75ºN and 32-37ºE; 1,500-8,000m asl. It contains parallel running rugged, steep and towering mountains with high peaks, highland plateaus and comparatively narrow valleys. Rivers and streams are fast moving, recharged by glacier melts or natural springs. The climate is dry temperate, with winter temperatures remaining below freezing, and summer temperatures reaching 44°C at lower altitudes. GB is not strongly affected by summer monsoons. However, winter monsoons are frequent and widespread. The snow and winter rainfall contribute to glacier ice accumulation and the recharge of ground water resources. Four vegetation types, i.e. subtropical broad-leaved forests, Himalayan dry temperate forests, sub-alpine forests and alpine scrubs are present in the area (Champion et al. 1964). The human population of 970,347 (1998 census; density 13.3/km^2) is mostly concentrated in towns or in open valleys suitable for agriculture, where water channels support active agriculture and orchard plantations. Areas under active agriculture are gradually increasing, and communication links are growing. Elsewhere, much of GB is desolate. Human settlements are limited to small, scattered houses or nomadic camps where people raise livestock. Much of the area supports wild biota.

Data collection

We used questionnaires to collect wolf information based on local knowledge. Questions included the location of wolves, the number of wolves seen together and the number of pups or juveniles observed with an adult female or pack. To gauge temporal shifts in wolf numbers we asked how many wolves were seen together during the last five (2001-2005), ten (1996-2000), 15 (1991-1995), and >15 (prior to 1990) years. The questionnaire further assessed attitudes towards wolves, knowledge about wolf persecution, and the availability of wolf parts in local markets. The questionnaire was developed using a structured interview form and written in Urdu. It was administered in early 2006 to local hunters and livestock herdsmen throughout GB. We interviewed individuals willing to participate and provide consent. Our interviewers completed appropriate training and had knowledge of both local languages and geographic area.

In 2006 we conducted field surveys (n = 49) of wolves in nine regions throughout GB. We used different numbers of randomly selected sample transects of varying lengths in different regions, depending upon size of wolf tracts and accessibility of the region. One researcher, accompanied by two to four local guides or hunters, travelled along roads and walking tracks by jeep (on road) or motorcycle (on narrow tracks) or on foot (on walking tracks). We recorded all wolves observed within 250m of either side of these survey transects. We also recorded all incidences of wolf droppings or tracks in the road or trail. Wolves often leave droppings in prominent places to serve as visual cues to other wolves (Peters and Mech 1975). Considering that wolves have large territories (Roberts 1997), we regarded all the droppings/tracks observed in survey transects as belonging to one individual, and ignored scat dataset for the transects where wolves were sighted. Herdsmen present in the area were questioned about recent wolf encounters, but this information was used to validate our wolf detection data and was not subjected to detailed analysis. The transect area surveyed was calculated at 6,187km^2 and mapped.

Data analysis

We obtained 150 questionnaire responses from different parts of GB. These were aggregated into 84 localities (Figure 1). While wolves in the region tend to have large home ranges of 150-180km^2 (Roberts 1997; Jhala and Giles 1991), news of wolf sightings or attacks spread quickly through neighbouring villages. Thus, multiple reports from a geographic cluster of villages might reflect multiple reports of the same wolf or wolf pack. Therefore, to avoid over-counting wolves, we aggregated wolf population estimates from the 84 localities into 21 regions for analysis. These regions were based on natural landscape barriers to wolf movement (such as the location and orientation of valleys), suitable wolf habitat and similar questionnaire responses with respect to estimated wolf population size. We provide minimum and maximum estimates of the number of wolves present in each of these 21 regions.

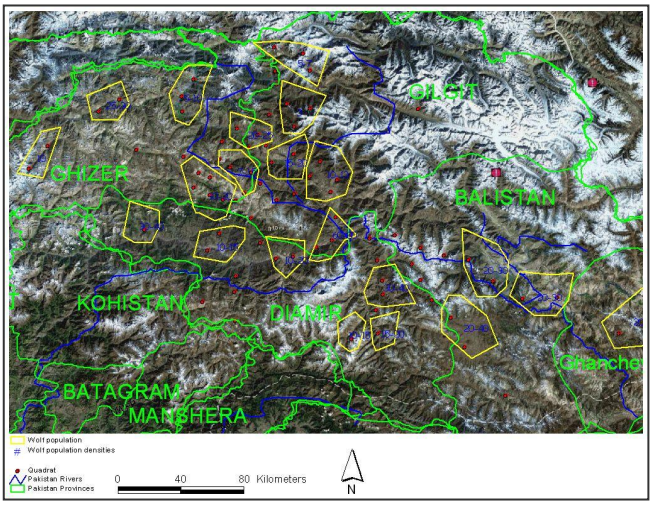

Figure 1. Wolf questionnaire study localities and distribution of wolf populations in 21 different regions of GB.

We also estimated wolf population density based on direct sightings. We divided the number of wolves observed or detected (in the form of tracks or droppings) by transect area to calculate population density for individual transects. We calculated mean density, and standard errors of means (SEM) for each of the nine field survey localities.

We considered wolves to be members of a pack if they were observed together and not engaging in intraspecific aggression. We calculated the relative frequencies of packs sizes, and the mean pack size and relevant SEM for each area, region and sampling year. We also calculated average pack sizes and relevant SEM separately for each time period from the sighting records conveyed by respondents to the questionnaires. The number of pups observed with an adult or a pack by questionnaire respondents was interpreted as litter size. Individual litter sizes were pooled to calculate the mean, SEM and relative frequencies of litters of different sizes. We also documented the vegetation in each locality where wolves were found, and classified it according to the vegetation types recognized by Champion et al. (1964).

Lastly, we used questionnaire data to evaluate the degree of wolf persecution. We used data from individual respondents to estimate the number of wolves killed in the area, taking into account responses from other individual respondents from the same locality. We also asked questions about people's fear of wolves, their reasons and means of wolf persecution and the market value of wolf products. These data were used to study overall patterns and were not quantitatively analysed as we were not testing hypotheses about wolf persecution.

Results

Responses from 150 questionnaires revealed that wolves appeared in 55 of 84 (65.5%) localities surveyed. Respondents reported seeing wolves in ravines, valleys and mountains of GB. No wolves were seen on steep mountains or in highland glacier tracts (Figure 1). Wolf population density estimates developed from questionnaire responses suggest a population of some 339-483 individuals distributed over 70,332km² of GB. This yields a density of 0.5-0.7 wolves per 100km² (Table 1, Figure 1). Approximately half of the total GB area consists of steep mountains or highland glaciers. Wolves were not seen in these areas, where there is insufficient prey and thus we consider these areas as unfavourable wolf habitat. Densities in favourable habitat were therefore recalculated as: 1.0-1.4 wolves per 100km². A large population of 60-80 wolves was reported for the Jagot Sai region. Medium-sized populations (20-40) were reported in Gupis, Darail, Sengul, Astor, Bagicha and Shigar. Small populations (<10) were reported in the remaining regions (Table 1).

Table 1. Wolf population size and persecution estimates in 21 regions of the GB, as reported on questionnaires.

Locality	Individual wolves (#)	Persecuted wolves (#)
Teru	10	7
Gupis	25-30	10
Darail	30-40	-
Imat	5-10	3
Sengul	20-25	3
Chapurson	5-7	7
Kharbor	3	-
Gulmit	15-20	5
Miachir	4-7	3
Chaport	10-20	4
Tausit	10-13	5
Harmosh	7-15	5-6
Minawar	7-15	2-4
Jagot Sai	60-80	7-23
Chilas	10-15	4
Astor	30-40	6-7
Pakore	10-15	4-5
Shantargarh	15-20	-
Dambudas	20-30	2
Bagicha	20-30	-
Shigar	20-30	3
Total	**336-475**	**66-87**

Results of 49 transect surveys distributed over favourable wolf tracts (Table 2) suggested an overall density of 1.1 ± 0.39 SEM wolves per 100km² for some 35,116km² of potential habitat, suggesting a minimum population of 386 ± 268 (95% C.I.) wolves for GB. Population densities were highest (>1.5/100km²) for Astor, Guda and Chaprot; intermediate (0.9-1.1/100km²) for Imat, Harmosh and Yasin; and the lowest (<0.7/100km²) for Teru, Singal and Dambudas. Mean densities of wolf populations in different vegetation types of GB (Table 3) were not significantly different from one another, suggesting no special preference for any vegetative type.

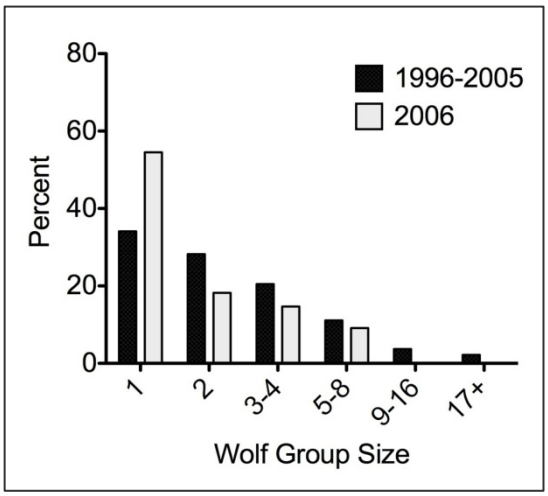

Figure 2. Frequency of pack sizes observed in GB during 1996-2005 (questionnaire respondents) and 2006 (field survey).

When wolves were directly observed during 2006 field surveys, 54.6% of all sightings consisted of single individuals (n = 21; Figure 2). The mean observed pack size was 2.0 ± 0.3 SEM. This was different from the data obtained from questionnaire respondents. Respondents reported observing wolves as single individuals in 34.1% of all sightings, and in groups of two in 28.2% of sightings during the previous ten years (1996-2005; n = 185, Figure 2). Frequencies of packs gradually decreased with increasing pack size, and packs of more than nine were rare. Average pack size reported by questionnaire respondents was 3.4 ± 0.3 SEM. The distribution of pack sizes was significantly higher in the 1996-2005 dataset than in the 2006 dataset (Kolmogorov-Smirnov test; P = 0.03). Data gleaned from questionnaires further suggested a 66% decline in pack size between 1990 and 2006 (Figure 3). Average pack sizes for 1996-2005 varied with locality. Mean pack size was the highest in Ghanche (7.0; n = 1), followed by Astor (5.2 ± 1.9 SEM; n = 24), Skardu (4.3 ± 1.4 SEM; n = 36), Gilgit (2.4 ± 0.2 SEM; n = 43) and then Ghizer (2.0 ± 0.3 SEM; n = 7).

Table 2. Population density of wolf in different localities of the GB sampled during late 2006.

Locality	Survey Transect n	Survey Transect Area (km²)	Wolf Sightings	Wolf Droppings	Wolf Total	Density ± SEM (per 100km²)
Teru	1	148	-	1	1	0.7
Yasin	3	316	1	2	3	0.9±0.53
Skingul	4	566	-	4	4	0.7±0.26
Imat	10	867	3	7	10	1.1±0.35
Chaprot	11	1832	24	-	24	1.3±0.57
Harmosh	12	1784	15	2	17	0.9±0.65
Astor	4	234	-	4	4	1.7±0.25
Gudai	2	124	-	2	2	1.6±0.39
Dambudas	2	316	3	-	3	0.6 ±0.15
Total	**49**	**6187**	**46**	**22**	**68**	**1.1±0.39**

Table 3. Distribution of average wolf density (± SEM per 100km²) in different broad habitat types in the GB during 2006.

Vegetation Type	n	Wolf density (/100km²)
Alpine scrubs	14	1.1 ± 1.80
Sub-alpine forests	8	1.0 ± 1.30
Subtropical montane broad-leaved forests	15	1.1 ±1.40
Himalayan dry temperate montane forests	15	0.9 ± 1.10

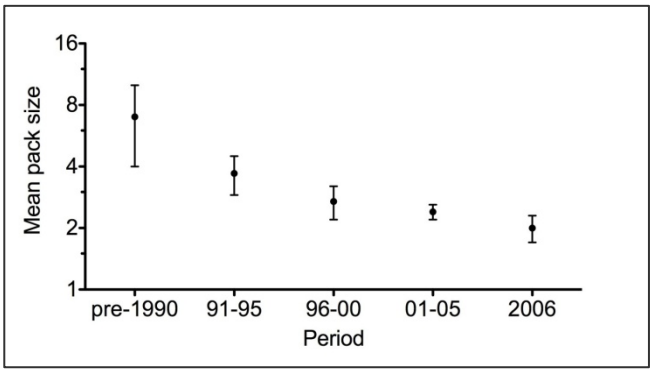

Figure 3. Mean wolf pack size (± SE) from pre-1990 to 2006. All data except 2006 comes from questionnaire respondents. Sample sizes are (n) = 13 packs (pre-1990), 27 (1991-1995), 41 (1996-2000), 54 (2001-2005) and 21 (2006). Note log scale of Y-axis.

The number of pups seen with adults reported by questionnaire respondents suggests that wolf litter size ranged between one and nine, with an average of 3.2 ± 0.3 SEM pups per litter (Figure 4).

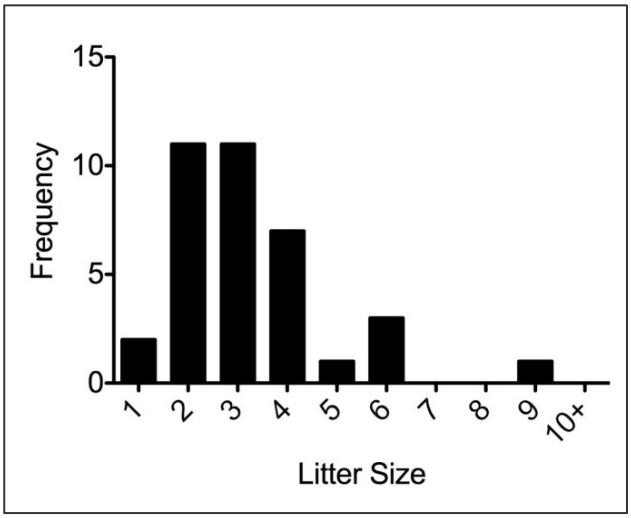

Figure 4. Frequency of litter sizes reported by questionnaire respondents (n = 36). The 2006 field survey noted two additional litters, one consisting of two pups, and one of five pups (not shown).

Reports collected from questionnaire respondents suggest a total of 66-87 wolves faced human persecution during 2005-2006 in different parts of GB (Table 1). Wolf persecution was relatively higher in Jagot Sai (7-23), Astor (6-7) and Gupis (10). Wolf population was also high in Jagot Sai (60-80) and Astor (30-40), but relatively moderate in Gupis (25-25). No wolf persecution was reported for Dural, Khaiber, Shankargarh and Bagicha, despite a moderate wolf population in these regions.

Respondents indicated firearms are the most frequent mode of injuring or killing wolves, which is exercised in all localities. Trapping (nine localities), poisoning (seven), nets (five) and snares (three) are also used in different combinations in different localities. Trapped/ netted/snared wolves are usually shot dead or are killed with axes, daggers or sticks. There was a single case of a wolf stoned to death (this occurred when the wolf became accidentally trapped in a livestock barn).

Questionnaire respondents indicated that they had little fear of being attacked by wolves. Such fear was only recorded in three localities (Gulakmula, Yasin, Dambudas). There appears to be no relationship between fear of wolf attacks and wolf population size. There is no wolf population in Gulakmula, and medium populations for Yasin and Dambudas. Moreover, respondents reported no cases of people being attacked by wolves, and that they thought wolves only attacked people when in packs. Responses from all localities indicate that wolves are persecuted to prevent depredation of livestock and poultry. Wolf persecution is frequently undertaken after a reported livestock predation. Such attacks were more common in winter.

There was evidence of an active trade in wolf parts, primarily pelts. In 2006, wolf pelts were available in many, but not all, local markets (exceptions being Miapin and Miachir), although they were widely available 20-25 years ago. In Ghizer, there are taboos against touching live or dead wolves; therefore wolf parts were less frequently encountered in markets there. A wolf pelt in this area was available at some Pakistani Rs. 100 (US $1.50). Elsewhere pelts were available for Rs. 300-400 in Bunji and Ramkha, Rs. 1,000-3,000 in Sakwar, Minawar, Pahot, Nurpur, Gulmit, Gilgit and Rs. 2,000-3,000 in Skardu and Ghanche. Some wolf pelts sold for up to Rs. 7,000-10,000 in Gulmit, Gor and Khinar, and were taken from these local markets to larger markets, possibly for export. Other body parts were also available for sale. Wolf fat, sometimes sold for local consumption, is believed to have aphrodisiac qualities. Wolf paws were considered to have some medicinal value, especially in the Gala Kmuli area of Ghizer. While prices for fat and paws could not be ascertained, they were reportedly fairly low. Wolf bones are thought to have supernatural value, but they were not available in these markets.

Discussion

Vast tracts of GB are barren hills and highland deserts with very scattered human settlements, and provide suitable wolf habitat (Roberts 1997), although no previous report are available on the wolf distribution range in GB. Roberts (1997) suggested a wide distribution for wolves, but only indicated their presence in Karabos, Bubind and Sadpara. Rasool (1998) suggested that wolves were present in almost all mountain ranges even in highland plateaus, and our study confirms this distribution.

Population estimates derived from questionnaire respondents (336-475) and field surveys 386 ± 268 (95% C.I.) are in reasonable agreement but differ in variability. The respondents were mostly subsistence livestock herders, and since wolves occasionally prey on livestock, herdsmen therefore tend to be knowledgeable about wolf presence and movements. The reliability of wolf population information possessed by nomadic herding tribes of Gajarat and Rajasthan, India has been highlighted elsewhere (Jhala and Giles 1991). In the absence of more expensive and logistically challenging methods such as capture, collaring and radio-telemetry (Hayes and Harestad 2000, Fuller et al. 2003) or molecularly-based applications in capture-recapture (Marucco et al. 2009), the combination of direct observations and local information was deemed sufficient to derive/attain a population estimate of 300-500 wolves in GB during 2006.

These numbers may initially appear to be high. However, we believe additional animals persist in the desolate tracts of GB, where ample suitable wolf habitat is available in the form of broken hills and valleys of different sizes. Our population estimate matches the findings by Jhala and Giles (1991) in two states of west India. They estimated 190-270 wolves in Gujarat, and 253-300 in Rajasthan. Our findings are contrary to expert opinion given at a recent conservation workshop (held in 2003 to collect estimates from wildlife enthusiasts on the status of different wild mammals in Pakistan) which concluded that there was only a small wolf population in GB, in or around the Deosai Plains (Sheikh and Molur 2005).

Population density was estimated at between 0.6-1.7 per 100km^2 in different surveyed tracts, with an average of 1.1 ± 3.9 SEM per 100km^2 for favourable wolf tracts of GB, which are somewhat lower than wolf densities reported elsewhere. Shafiq and Ali (1998) reported a wolf density of 2.2 per 100km^2 in Khunjrab National Park (northern GB), comparable to those recorded for Astor, Guda and Chaprot in this study. Wolf density varied from 1.8-9.0 per 100km^2 over a 50-year period in a small population of wolves in Isle Royale in Michigan, USA, where they were fully protected from persecution and had ample prey (Nelson et al. 2011). In Golan, Israel, densities of 8-10 wolves per 100km^2 were reported for a population at carrying capacity level (Reichmann and Sultz 2005).

The study returned nearly equal density estimates for the four vegetative types available in GB, reinforcing the idea that wolf numbers do not correlate with vegetation structure (Fuller 1989). Prey density is a much stronger determinant of habitat selection by wolves (Fuller 1989, Fuller et al. 2003).

Fuller et al. (2003) reported average pack sizes ranging from three to 11. Data from our 2006 field survey suggested average pack size of 2.0 ± 0.33. Pack sizes of two to seven have been reported for Golan, Israel (Reichmann and Sultz 2005). Three packs in southern India comprised of two, six and 11 individuals (Jhala and Giles 1991). Lone wolves appeared in 33.5% of the sightings in Spain (Blanco and Cortes 2007) compared to 55% of sightings in the current study, suggesting that lone wolves were more frequent in the GB wolf population than in the Spanish population. There are no studies on prey consumed by wolves in GB and the relative availability of prey species. Wildlife enthusiasts and hunters report a recent decline in populations of large ungulates, e.g. ibex *Capra ibex* and markhor *C. falconeri*. Prey species of smaller size, e.g. long-tailed marmot *Marmota caudata*, stone marten *Martes foina*, Cape hare *Lepus capensis* and red fox *Vulpes vulpes* are more frequent. We believe that the wolves in GB are feeding on smaller prey.

Questionnaire respondents consistently reported a gradual decline in the wolf population in all regions of GB during the current study, and this finding matches the report by Rasool (1998). It is unclear if the gradually decreasing wolf pack size in GB over the years is an attribute of a decline in large prey species or a reflection of wolf persecution and mortality. Reports of pups by questionnaire respondents indicated a breeding population of wolves in GB. This was corroborated by the sighting of two different females with two and five pups respectively during the 2006 field survey. Litters sizes of up to five pups have been frequently reported in different general description on wolf species (Fulton 1903, Prakash 1960, Yadav 1968, Roberts 1997). Recent studies reported 5 ± 2 pups per pack for the Golan wolf population (Reichmann and Sultz 2005) and two to eight pups for the Alaska wolf population (Adams et al. 2008).

We have no wolf mortality data for GB. A life expectancy of 23-64 months has been reported for Golan wolf populations (Reichmann and Sultz 2005), and a mortality rate of 20-40% per year in grey wolf (Harrington et al. 1982). Human-caused mortality affected 19-22% of the population (of 350-400) during 2004 (Table 1). When news of both wolf depredation of livestock and human retaliation against wolves becomes widely circulated in the area, herdsmen take notice. Therefore, these estimates on wolf persecution appear sufficiently reliable. The reported number of persecuted wolves per region corresponded somewhat with wolf population levels. A higher rate of wolf persecution is expected in areas with fewer wolves and a higher human population, and where a higher frequency of wolf attacks on livestock may arouse a severe reaction from herdsmen. A lower rate of wolf persecution is expected where wolves are not in direct conflict with herdsmen, even where there are many wolves.

Questionnaire respondents indicated no public passion for wolf hunting in GB. People do not fear attacks from wolves, even in localities having appreciable wolf populations. Moreover, there have been no reports of wolf attacks on people for several years. Wolves are thought to attack people only when in large packs (Rasool 1998). If true, the small pack sizes observed suggests that wolves in GB pose little threat to people. It appears that wolf persecution in GB only occurs to ensure the safety of the livestock. Livestock form the basis of local economies. Therefore, wolf depredation of livestock provokes retaliation. We confirmed wolf depredation of livestock (sheep and goats) on two different occasions. Incidence of wolf depredation decreases as the size of the wolf population declines (Treves et al. 2011), but other factors may be important as well. The recent decline in wild large ungulate populations in GB has correspondingly increased conflicts between people and wolves. There is no data on the losses sustained by herdsmen of GB through wolf depredation, but a study conducted in three villages in central Himalayas suggested an average loss of $US190/household/year (Namgail et al. 2007). Reports from the area suggest that retaliation against wolves mainly occurs in winter, when wild food is scarce. Wolf conservation in GB will need to focus on helping herdsmen effectively protect their livestock, encouraging people to dispose of animal remains away from barns and settlements and developing conservation plans to ensure the sustainable use of wild foods.

We do not have demographic data on those wolves facing human persecution. There is no traditional trapping/killing of wolf pups in GB. Circumstantial evidence suggests that sick, weak or old wolves that can no longer kill prey in the wild are attracted to human settlements where livestock and poultry are easy to kill. Persecution against these animals would probably not affect the growth rate of the wolf population. Inexperienced sub-adults may also approach human settlements and attack livestock. This occurs in the Golan wolf population, where some 51% of persecuted wolves are sub-adults (Reichmann and Sultz 2005). If sub-adults are being persecuted in GB, this could have a significant impact on the wolf population.

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