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Characteristics of Gray Wolf Attacks on Humans in an Altered Landscape in the West of Iran

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*Wildlife attacks on humans are an example of serious human–wildlife conflict. Such attacks are rarely studied in Asia and particularly not in Iran. A total of 53 wolf (*Canis lupus*) attacks were recorded on humans in the Hamedan province, a human-dominated landscape in west Iran, between April 2001 and April 2012. Most attacks were classified as predatory (68%) and pet-related (19%) in nature. The majority of victims were children (12 years old or younger; 62%). Most incidents (70%) took place during the wolf's pup-rearing season. The most frequent human activities at time of attack were recreation based (57%). The locations of attacks occurred frequently in the farmlands (43%) and outskirts of villages (41%). We recommend that future wolf attacks could be reduced or prevented through modification of human behavior and public education designed to prevent the habituation of wolves.*

Keywords *Canis lupus*, Hamedan province, human-dominated landscape, human–wolf attack, Iran

Introduction

Wildlife attacks on humans are a rare occurrence but are a serious challenge of wildlife management (Brown & Conover, 2008; Worthy & Foggin, 2008). Attacks by mountain lions (*Puma concolor*), brown bears (*Ursus arctos*), black bears (*Ursus americanus*), polar bears (*Ursus maritimus*), coyotes (*Canis latrans*), and tigers (*Panthera tigris*) on humans have been documented around the world (Herrero & Higgins, 1999, 2003; Löe & Röskaft, 2004; McDougal, 1987; Torres, Mansfield, Foley, Lupo, & Brinkhaus, 1996; White & Gehrt, 2009). When attacks involve large carnivores, the consequences affect the victim, their families, and the surrounding community (Löe & Röskaft, 2004). These severe interactions influence the public's attitudes toward wildlife and wildlife management practices (Chauhan, Bargali, & Akhtar, 2002; Mohan, 1997; Ogra, 2009; Wang, Lassoie, & Curtis, 2006). The local response to attacks on humans often involves community-organized hunting campaigns (Sillero-Zubiri & Switzer, 2004; Treves et al., 2004). Retaliation hunts can threaten the survival of large carnivores (Liu et al., 2011; Pettigrew et al., 2012).

To minimize carnivore attacks on humans, the details of attacks need to be investigated (Löe & Röskaft, 2004). Evidence suggests multiple factors can be involved in

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an attack, such as the offending animal's behavior, demographics of victims, seasonality of attacks, and victims' activity during the attack. Understanding these details can help prevent future attacks through the understanding of patterns (Gurung, Smith, McDougal, Karki, & Barlow, 2008; White & Gehrt, 2009). This situation is epitomized in Hamedan province in west Iran, where human–wolf conflicts have increased in recent years. Until now, there has been no research on the patterns of human–wolf conflicts in west Iran.

The grey wolf (*Canis lupus*) has one of the largest geographical distribution ranges of mammalian carnivores and is found in a wide variety of habitats (Mech & Boitani, 2004), including arid environments in the Middle East (Hosseini-Zavarei, Farhadinia, Beheshti-Zavareh, & Abdoli, 2013; Mech & Boitani, 2003). Wolves exist throughout most parts of Iran, but are subject to heavy illegal persecution mainly as a response to the increasing level of conflict with rural communities (Ziaie, 2008). Human–wolf conflicts occur due to the encroachment of human activities onto the wolf's natural habitat, especially from extensive land use and a subsequent reduction in wild prey (Löe & Röskaft, 2004; Ziaie, 2008). With lower prey populations, wolves feed on human sources of food (such as garbage), which brings the species into close contact with humans.

Globally, rabid wolves have committed the majority of wolf attacks on humans. Other types of wolf attacks on humans have involved attacks on a person trying to intervene in a wolf attack on a pet, defensive attacks by a wolf that was trapped or cornered, a wolf protecting a den site with pups, or attacks by wolf–dog hybrids (Linnell et al., 2002). There are recorded historical incidences of wolf attacks on people (rabid and non-rabid) in Iran (Baltazard & Ghodssi, 1954; Linnell et al., 2002); particularly in western Iran in the Hamedan province. Between 1900 and 1949, 325 cases of attacks by rabid wolves on humans in Iran were recorded; 60 of these cases were fatal (Linnell et al., 2002). Non-rabid wolf attacks on people have also been documented in Iran. One such incidence, reported by Baltazard and Ghodssi (1954), involved a pack of 50 wolves inhabiting mountains near Zanjan in western Iran that attacked the town on several occasions during the night or early hours of morning, taking several young children and wounding about 40 people until an extensive battue stopped the attacks. Although wolf attacks on humans are rare worldwide, and death incidents even less frequent (Linnell et al., 2002; Sillero-Zubiri & Switzer, 2004), an increase in the number of fatal wolf attacks on humans in recent decades in Hamedan reveals a high level of human–wolf conflicts in this province. Local residents perceive wolves as a security threat and try to eradicate them.

Addressing safety concerns and providing information on patterns of human–wolf conflicts are important steps in achieving conservation and tolerance of wolves by local communities. Since this subject has rarely been addressed across the range of wolves in Asia (Jhala & Sharma, 1997; Rajpurohit, 1999; Shahi, 1983), we investigated patterns of wolf attacks on people in human-dominated landscapes in this western region of Iran. Such information is essential for better understanding, management, and ultimately a decrease in the number of future human–wolf conflicts. The objectives were (a) to identify patterns of seasonal and temporal wolf attacks on people in Hamedan province, (b) to investigate possible relationships between victims' demographics and attack types, (c) to identify human activities that make people vulnerable to attacks, and (d) to determine the types of locations where attacks took place.

Methods

Study Area

The study area was the Hamedan province in western Iran. The province is 19,493 km^2 (Figure 1). The province consists of eight counties, 27 cities and 1,085 villages. About 52% of people of the region live in villages (population for each village is <5,000) and the main economic activities are agriculture and livestock husbandry (Reyahi Khoram & Fotros, 2011). Hamedan province is considered one of the most important regions of agriculture in the country. As a result of extensive cultivation activities, most of the study area comprises a homogenous landscape of agricultural matrix of orchards, intensive irrigated farms and scattered dry farms of cereal. The cover percentage of rangelands and croplands in Hamedan province is 33% and 32%, respectively, whereas only 2% of the province consists of a fragmented patch of deciduous forest, which is covered by mostly Persian oak (*Quercus brantii*) (Safikhani, Rahiminejhad, & Kalvandi, 2007). Major wild ungulate

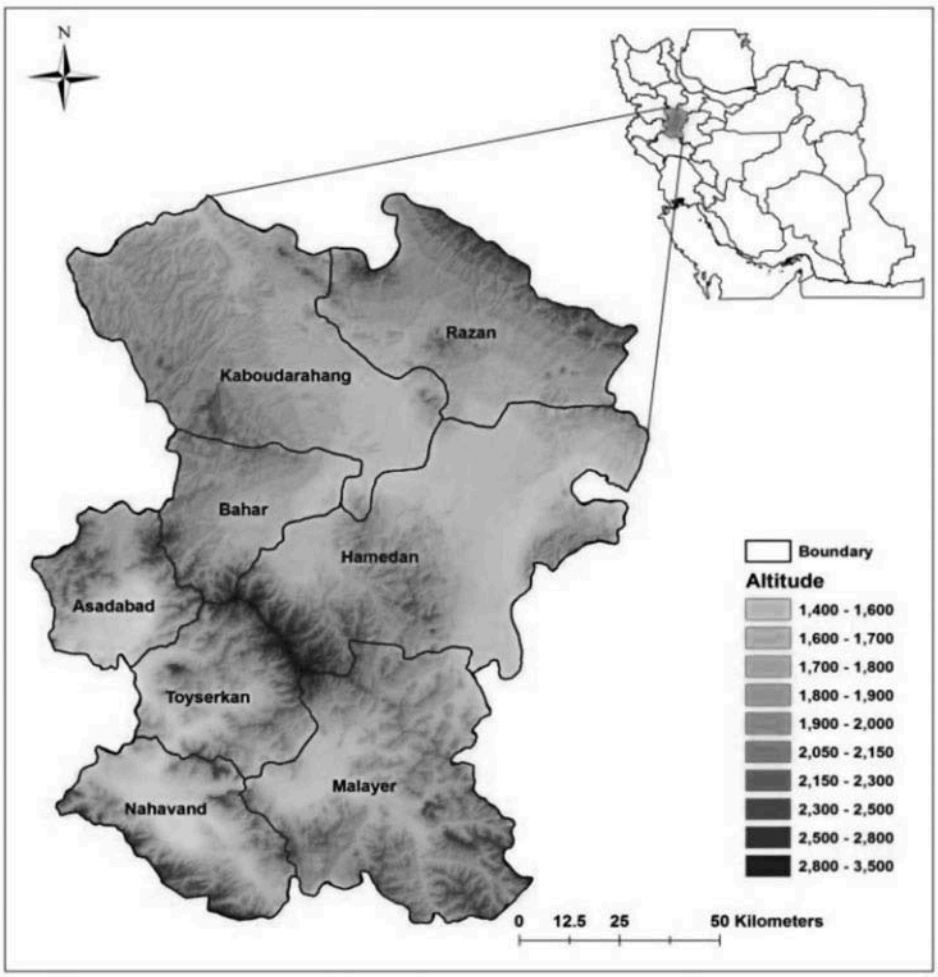

Figure 1. Study area and its location in Iran.

species of the region are wild goat (*Capra aegagrus*), wild sheep (*Ovis orientalis*), and wild boar (*Sus scrofa*), whose population is restricted only to protected areas (Ahmadi, Kaboli, Nourani, Alizadeh Shabani, & Ashrafi, 2013).

Analysis

Information on wolf attacks on humans was collected between April 2001 and April 2012. We recorded the locations of wolf attacks in the field by preparing a list of attack sites based on compensation reports related to wolf attacks on people at the Department of Environment (DoE) of Hamedan province. The villages mentioned in the list were visited and 53 locations were identified. Based on face-to-face interviews with the victims, victims' families, and witnesses to the incident, we recorded the age and sex of the victim, place of attack, activity of victim at the time of attack, and date and time of day when the attack happened. Since the majority of offending wolves in Hamedan province were killed by local people or rangers of the DoE, we also considered the results of rabies tests (confirmed by the Pasteur Institute of Iran, the official responsible for monitoring of rabid disease in Iran). We examined the genetics of the wolves to test for cross breeding. Genetically pure wolves were confirmed by genetic analysis using D-Loop, Chromosome Y, and 12 autosomal microsatellite loci (Khosravi, Rezaei, & Kaboli, 2013).

Victims were classified as adult or children. Victims were considered a child if they were 12 years old or younger (Linnell et al., 2003). The major biological phases of wolf life were classified into three seasons corresponding to breeding (January through April), pup-rearing (May through August), and dispersal (September through December) seasons (Edge, Beyer, Belant, Jordan, & Roell, 2011; Jhala, 2003; Mech, 1970). The time of attacks was categorized into five periods: morning (0600–0900), forenoon (0900–1200), afternoon (1200–1500), evening (1500–1800), and night (1800–0600). Based on studies by Linnell et al. (2002), McNay (2002), and White and Gehrt (2009), we classified the attacks into five categories: defensive, pet-related, rabid, predatory, and investigative.

Defensive attacks were defined as incidents in which a wolf was trapped or cornered or when den sites with pups were threatened. Defensive behaviors were typically provoked by human intrusion or aggression. Pet-related attacks were defined as incidents in which a person was bitten while a pet animal was present. In these cases, the pet may have been involved in attracting the wolf to the person. In some cases, the victim may have been trying to rescue a pet animal from a wolf attack when he or she was attacked. Rabid attacks were defined as cases in which the offending wolf was diagnosed with rabies. Predatory attacks were defined as a series of connected behaviors involved in hunting prey. These behaviors include orientation toward the prey, following, attacking, and in the case of small prey, carrying and finally taking the prey. In this category, most or all of these behaviors were observed in cases we categorized as predation. Investigative attacks were defined as incidents in which the victim was immobile, sleeping, or resting when he or she was attacked. In such cases, it seems that the wolf tests the victim as possible prey.

Because some categories had small samples, we combined investigative, defensive, and pet-related attacks into a non-predatory category (Behdarvand, 2012; McNay, 2002; White & Gehrt, 2009). The frequency of predatory and non-predatory attack categories between gender, age, season, and attack time was compared among groups using χ^2 tests ($p < .05$).

Results

Between April 2001 and April 2012, we recorded 53 incidents of wolf attacks on people. Most of these attacks occurred in north and central regions of the province, particularly

Bahar (36%), Kaboudarahang (13%), and Hamedan (11%) counties. Sixty-eight percent of the attacks were classified as predatory, 14% ($n = 5$) of which were lethal to humans. Victims killed were 3–6- year-olds. Attacks were classified as pet-related, investigative, and defensive in 19%, 9%, and 4% of the cases, respectively. None of the cases examined in Hamedan province involved rabid wolves.

The victims were mostly children ($n = 33$), followed by adult men ($n = 12$), and adult women ($n = 8$; Table 1). Children were significantly involved more in predatory attacks than non-predatory types ($\chi^2 = 9.53$, $df = 1$, $p = .002$; Table 2). Adults were involved more in the non-predatory attack types than children, especially in pet-related attacks (Table 1).

In attacks involving children, there was no significant difference between the sexes ($\chi^2 = 0.76$, $df = 1$, $p = .38$). Between the predatory and non-predatory attack categories, there also was no significant difference in sexes for children ($\chi^2 = 0.13$, $df = 1$, $p = .71$). Among adults, male victims were more frequently reported than females (Table 1), but this was not significant ($\chi^2 = 0.81$, $df = 1$, $p = .37$). Between the predatory and non-predatory categories, however, significant differences ($\chi^2 = 4.59$, $df = 1$, $p = .03$) were observed in sex ratios for adults. More adult females were involved in predatory attacks ($n = 6$) than in non-predatory attacks ($n = 2$; Table 2).

Most incidents were recorded during the pup-rearing season (70%; $n = 37$; $\chi^2 = 31.84$, $df = 2$, $p = .001$). Similarly, more predatory attacks were recorded during the pup-rearing season ($\chi^2 = 6.15$, $df = 2$, $p = .04$; $n = 29$) than in other seasons ($n = 7$; Table 2). Overall, there was no significant difference ($\chi^2 = 4$, $df = 3$, $p = .26$) in the time of attack incidents.

Table 1
Demographics of victims in the types of wolf attack ($n = 53$) in Hamedan province, April 2001–April 2012

		Demographic of victims		
Attack types	Adult male	Adult female	Child male	Child female
Defensive	2	0	0	0
Predatory	2	6	16	12
Pet-related	6	1	2	1
Investigative	2	1	1	1

Table 2
Age and sex distribution of victims and seasonal variation of the predatory and non-predatory of wolf attacks ($n = 53$) in Hamedan province, April 2001–April 2012

	Age group		Gender				Season		
Attack types	Adult	Child	Adult male	Adult female	Child male	Child female	Breeding	Pup rearing	Dispersal
Predatory	8	28	2	6	16	12	4	29	3
Non-predatory	12	5	10	2	3	2	5	8	4

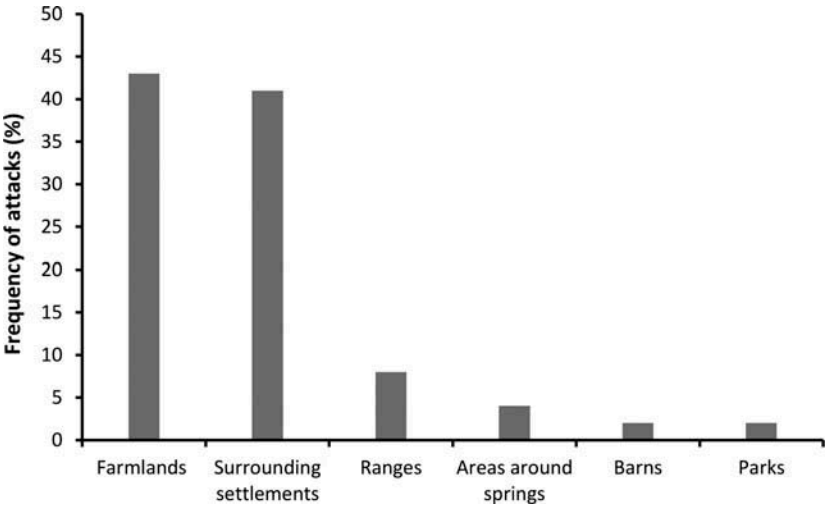

Figure 2. Locations of wolf attacks on people ($n = 53$) in Hamedan province, April 2001–April 2012.

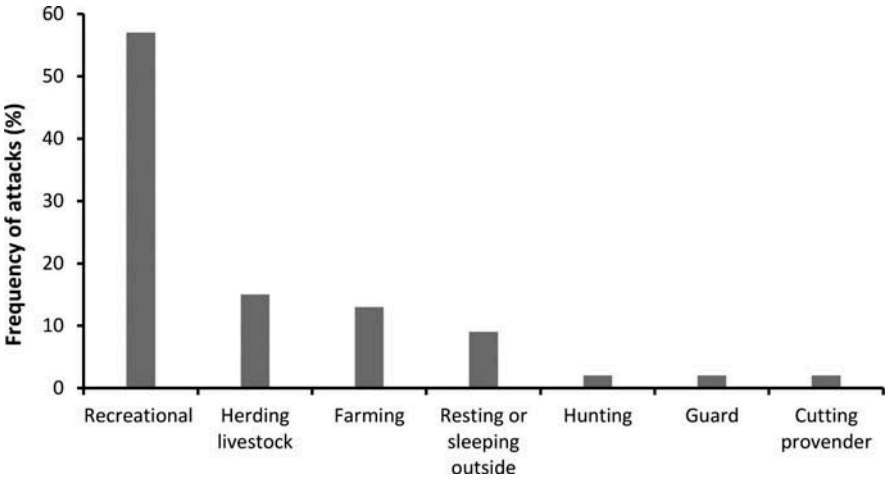

Figure 3. Activity of victims at the time of attacks by wolves ($n = 53$) in Hamedan province, April 2001–April 2012.

The same results were recorded in predatory and non-predatory attack categories ($\chi^2 = 0.51$, $df = 4$, $p = .97$). Most incidents occurred in farmlands and orchards of the provinces (43%; Figure 2). The other most common places were around villages and settlements (41%).

More incidents occurred when victims were involved in recreational activities (e.g., playing and walking; 57%) than in other activities (Figure 3). The majority of child victims (82%) were playing within farmland and around villages at the time of the attack. Attacks were also recorded when victims were busy with livestock grazing (15%). This is primarily more of a man's task than a woman's and more often ($n = 6$) men were attacked in this type of activity.

Discussion

We did not find any cases of attacks on people by rabid wolves or wolf–dog hybrids. Laboratory tests showed that there was no case of rabies among the offending wolves that were captured and tested. Incidents of wolf attacks in Hamedan province also lack the characteristics of rabid attacks since the victims were mostly children and in all cases, only a single victim was injured (as opposed to attacks by rabid wolves, which tend to occur on several people over a short period of time and exhibit no pattern in the age or sex of victims; (Linnell et al., 2002, 2003).

We did not find evidence of attacks on humans by wolf–dog hybrids in Iran, although wolf attacks on humans in other countries such as Spain, India, Lithuania, and Italy have been attributed to wolf–dog hybrids (Mech & Boitani, 2003). Hybrids show more aggressive and unpredictable behavior than pure wolves (Busch, 2007; Sacks, Blejwas, & Jaeger, 1999), are fearless and easily habituated to humans, and are more likely to live in the vicinity of human settlements (Rajpurohit, 1999). Although the highly modified landscape of our study area augments the chance of wolf–dog hybridization, genetic studies (Khosravi et al., 2013) revealed that none of the examined carcasses of the offending wolves belonged to hybrids.

According to our findings, most wolf attacks on people in west Iran were predatory attacks. Five of the wolf attacks reported were fatal on children. In others instances, local people came to the victim's rescue and the wolf was scared off or killed. Children killed were attacked while they were playing in farmlands, or in the outskirts of villages. Interviews with witnesses reveal that the wolves generally hunt in groups of 2–5 individuals. Pack members hide behind vegetation or other structures in the outskirts of villages and the attack is made by one individual. The victim is then consumed by the wolf and the remaining bits of clothing are what are found of them.

Energy requirements for wolves increase during late spring and early summer when wolves are giving birth, nursing their young, and feeding their pups (Edge et al., 2011; Jhala, 2003). We found an increased number of wolf attacks between July and August (Table 2), a timing recorded commonly for predatory wolf attacks similar to findings in other studies (Linnell et al., 2002; Rajpurohit, 1999).

According to our findings, 19% of wolf attacks were classified as pet-related. Most of the attacks were recorded when victims were busy with livestock (goat and sheep) grazing. There are historical and contemporary records of shepherds being bitten on the hand or foot when they confront a wolf trying to kill livestock or dogs (Linnell et al., 2002). Livestock husbandry in highly modified landscape of Hamedan Province consists of herds freely grazing in farmlands and rangelands near human settlements, cared by a few shepherds and guard dogs. The low availability of wild prey and the lack of proper husbandry methods cause the attraction of wolves to these areas. Not only can such cases cause increased depredation on livestock by wolves (Meriggi, Brangi, Matteucci, & Sacchi, 1996; Tuğ, 2005), but they may also lead to wolf attacks on the shepherd who is trying to rescue livestock from a wolf.

There are a number of cases in which wolves have bitten people after approaching them closely with no fear of humans. In such cases as these, it seems that the wolves may be testing or investigating the person as potential prey (McNay, 2002). Most of the investigative attacks were recorded in Hamedan province when people were immobile, resting in the farmlands or outdoors. In these attacks, injuries to the victims were usually minor and the offending wolves were usually simply scared away by the victims or eyewitnesses with little effort.

Wolves resort to aggressive behavior in self-defense when other avenues of escape are not available (Linnell et al., 2002; McNay, 2002). In our study, defensive attacks by wolves were observed when local people tried to corner and kill the offending wolves. As in investigative attacks, injuries to the victims were usually minor and the offending wolves easily escaped if possible.

Although the majority of wolf attacks on humans in the world are attributed to rabid wolves and wolf–dog hybrids (Linnell et al., 2002; McNay, 2002; Mech & Boitani, 2003), predatory wolf attacks on humans have been recorded (Linnell et al., 2002, 2003; Rajpurohit, 1999). In previous studies, the majority of predatory attacks by wolves have occurred in very artificial environments (e.g., where natural habitats are mostly destroyed; Linnell et al., 2002; Löe & Röskaft, 2004). The same types of attack location patterns were observed in the Hamedan province, especially in Bahar and Kaboudarahang counties where most of the attacks occurred. Agricultural expansion from 11% in 1989 to 27% in 2008 has destroyed almost all natural forests (Imani Harsini, 2012). Wolf packs were observed in agricultural fields that were once covered in vegetation suitable for breeding and raising pups. Forty-three percent of attacks took place in agricultural lands, especially corn fields, which may have provided suitable cover for wolves to attack. Similar events have been encountered in modified landscapes in India where large predators concealed by tall vegetation attacked humans (Athreya, Odden, Linnell, Krishnaswamy, & Karanth, 2013).

Wolves are usually wary of and avoid humans. However, improper household waste disposal methods practiced in the area (Hasanzadeh, Kaboli, Khosravi, & Ahmadi, 2012), as well as the availability of livestock near villages, attracts hungry wolves to the outskirts of villages resulting in their habituation to human presence, and thus an increase in predatory attacks (Eggermann, Da-Costa, Guerra, Kirchner, & Petrucci-Fonseca, 2011; Krithivasan, Athreya, & Odden, 2009; Llaneza, López-Bao, & Sazatornil, 2012).

It is most likely that rural communities could play a leading role in preventing future wolf attacks, as 41% of the attacks took place around villages. One of the key strategies for reducing human–wolf conflicts is to train local communities on how to coexist with wolves and prevent conflicts (Boggs, 1991). Instruction in proper waste management, informing the general public of wolf behavior, and how to reduce food attractants are important steps for reducing predatory attacks in these areas. Training local ranchers, proper husbandry methods such as the number of shepherds required for each herd, the number and appropriate race of livestock guard dogs, how to properly take care of livestock on rangelands, and correct methods of disposal of livestock carcasses would be effective.

Since most victims in Hamedan province were children (62%), parents should not leave their young children outdoors or around agricultural land without care. Unattended children in such circumstances are easy defenseless targets for wolves (Rajpurohit, 1999).

Finally, considering the lack of information on biology and ecology of wolves in Iran, especially in areas where wolf attacks have been reported, it is essential to survey wolf habitats, monitor problematic wolves, identify wolf dens and rendezvous sites, estimate the total wolf population, and determine the territory of wolves in the area. These efforts must be organized to involve local people, managers, and wildlife experts.

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