



Sheep and wolves: Is the occurrence of large predators a limiting factor for sheep grazing in the Czech Carpathians?



Petr Kovařík^{a,*}, Miroslav Kutal^{b,c}, Ivo Machar^d

^a Nature Conservation Agency of the Czech Republic, Administration of Litovelské Pomoraví Protected Landscape Area, Husova 5, 784 01 Litovel, Czech Republic

^b Department of Forest Protection and Wildlife Management, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 1, 613 00 Brno, Czech Republic

^c Friends of the Earth Czech Republic, branch Olomouc, Dolní náměstí 38, 77200 Olomouc, Czech Republic

^d Department of Biology, Faculty of Education, Palacký University, tř. Svobody 26, 771 46 Olomouc, Czech Republic

ARTICLE INFO

Article history:

Received 27 June 2013

Received in revised form 2 June 2014

Accepted 3 June 2014

Keywords:

Grazing

Brown bear

Eurasian lynx

Farmers attitude

Grey wolf

Large carnivores

Sheep breeding

ABSTRACT

Extensive sheep grazing in the West Carpathians is a very important management tool for the protection of the traditional landscape character of the Central European countryside, as well as providing biologically valuable habitats of pastures and meadows. In this paper we describe the main characteristics of sheep farming in the Beskydy region and test the hypothesis that large carnivores are a limiting factor for sheep grazing management of landscapes in this region, the only area of the Czech Republic where all three species of large European carnivores – the Eurasian lynx (*Lynx lynx*), grey wolf (*Canis lupus*) and brown bear (*Ursus arctos*) – occur. Data obtained from the monitoring of large carnivores and a questionnaire-based survey of the perspective of sheep farmers in the Beskydy region were analysed. Although the lynx is the most abundant large predator within the study area, the highest number of attacks on sheep was attributed to wolves. However, the annual frequency of attacks was very low and, moreover, an important number of the attacks could have been committed by dogs rather than wolves. From the perspective of sheep breeders, the major economic factor is a low consumer demand for sheep products, and not the presence of large carnivores. However farmers expressed a view that some level of safeguarding was needed and this should come in the form of financial compensation for damage resulting from attacks on sheep by large predators and a modification of the current system of agricultural subsidies. Subsidies for sheep breeders should respect the regional specifics including the risk arising from the presence of large carnivores and provide support for active measures to protect the livestock against them. Regarding the protection of populations of large carnivores in the Beskydy Mountains, it will be necessary to continue to monitor their presence.

© 2014 Elsevier GmbH. All rights reserved.

Introduction

In the cultural landscape of Central Europe, sheep breeding has traditionally been an important way of farming, which still helps maintain the typical character of foothill and mountain areas (Halladay & Gilmour 1995). Extensive sheep grazing also contributes significantly to preserving the non-forest biotopes of pastures and meadows that facilitate high gamma-biodiversity in the landscape (Metera et al. 2010). However, sheep farming has nearly disappeared from many areas of Central Europe during recent decades (Martinát et al. 2008; Niznikowski et al. 2006). A

reduction or removal of sheep grazing in the Czech Republic will lead to the further degradation of valuable grassland biotopes and the disappearance of a wide range of habitats of rare plant and animal species of European importance (Chytrý et al. 2010; Krahulec et al. 2001).

One of the regions in the Czech Republic which still preserves the traditional landscape character and high biodiversity owed to sheep grazing (and other livestock) are the Beskydy Mountains, situated at the edge of the West Carpathians (Weissmannová 2004). The Beskydy Mountains are also the only region in the Czech Republic where it is possible to come across all three species of European large carnivores – the Eurasian lynx (*Lynx lynx*), grey wolf (*Canis lupus*) and brown bear (*Ursus arctos*) – which pose an element of risk to the livestock (Kaczensky 1996). All three species cause a small degree of loss of domestic animals, but the extent of

* Corresponding author. Tel.: +420 775075310.

E-mail address: kov.petr@seznam.cz (P. Kovařík).

Table 1

Number of registered farms dealing with sheep and goat breeding and the number of farmed animals within the districts of Vsetín, Nový Jičín and Frýdek-Místek in 2011 (source: database of Ministry of Agriculture of the Czech Republic); territorial part of each district covered by PLA Beskydy (source: Czech Statistical Office).

District	Vsetín	Nový Jičín	Frýdek-Místek	Total
Number of farms	578	400	792	1770
Sheep	9171	3758	6967	19896
Goats	680	376	508	1564
Total number of animals	9851	4134	7475	21460
Part of district in PLA (%)	55	7	43	37

depredation varies in relation to local conditions (Kaczensky 1996; Swenson & Andrén 2005). Also the attitude of people towards large carnivores is variable, but very often negative (Kaltenborn et al. 1999). The risk of predation on domestic ungulates could be influenced by the abundance of carnivores (Kaartinen et al. 2009) and by the abundance and accessibility of livestock in a certain region (Meriggi & Lovari 1996). Although the existence of large carnivores in the Beskydy region is a long-term topic of discussion between conservationists and sheep breeders (Pavelka & Trezner 2001), there is currently no available research to help evaluate the relationship between sheep farming, the existence of large carnivore and attitudes of sheep breeders as key stakeholders.

In this paper we describe the main characteristics of sheep farming in the Beskydy region and test the hypothesis that large carnivores are a limiting factor for sheep grazing management of local landscapes. We attempt to answer four main questions, these are: (1) what is the state of sheep farming in the Beskydy region; (2) what is the abundance of large carnivores in the Beskydy region; (3) what is the frequency of attacks on farmed sheep by carnivores; and (4) what do sheep farmers consider to be the limiting factors for sheep breeding and do they include large carnivores? Subsequently, we considered the limits of long-term maintenance of sheep grazing management in the Beskydy Mountains and offer possible solutions to conflicts between sheep farmers and large carnivores.

Methods

Study area

The research was performed in the Beskydy Mountains (Czech Republic, 49°27'N, 18°21'E), primarily in the area situated within the boundaries of Beskydy Protected Landscape Area (PLA) (see Fig. 1). Beskydy PLA (1160 km²) is the largest PLA in the Czech Republic and belongs to the districts of Vsetín, Frýdek-Místek and Nový Jičín (Table 1). The Beskydy Mountains form part of the Outer Western Carpathians and comprise the Moravian-Silesian Beskids Range, the Vsetínské vrchy Range and the Moravian part of the Javorníky Range. The altitude is 350–1323 m a.s.l. and the land is characterised by a high diversity of habitats – various types of forests, ridge-top meadows and pastures together with hamlets scattered throughout the area (Demek 1987; Weissmannová 2004). Many rare plant and animal species occur here (Weissmannová 2004), including large carnivores – the Eurasian lynx (*Lynx lynx*),

Table 2

Occurrence of large carnivores in the Beskydy Mountains (indices of wolf, lynx and bear presence), monitoring intensity (number of square-days) and the area monitored in 10 × 10 km EEA squares.

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Wolf	3	3	5	4	7	8	4	4	0
Eurasian lynx	14	18	20	29	23	41	35	53	73
Brown bear	0	0	1	1	3	3	2	2	0
Monitoring intensity	76	104	209	232	250	276	393	343	499
Monitored area (km ²)	1600	1600	1800	2300	2400	2300	2400	2300	2400

grey wolf (*Canis lupus*) and brown bear (*Ursus arctos*). The Beskydy region is one of the two most important areas of lynx occurrence in the Czech Republic and it is the only region in the Czech Republic where wolves and bears occur simultaneously (Anděra & Červený 2009). However, it represents only a border area of regular wolf and bear occurrence and their presence at this western border of the Carpathians is variable (Anděra & Červený 2009; Bartošová 1998; Červený & Koubek 2003).

Data collection and analysis

The exact number of farms or sheep bred within the study area is currently unknown but it is possible to obtain an approximate number based on the extent of sheep breeding using official figures of registered farms from selected districts of Vsetín, Nový Jičín and Frýdek-Místek. This data was obtained in 2012 from the database of the Ministry of Agriculture of the Czech Republic.

Data on the occurrence and abundance trends of large carnivores (Eurasian lynx, grey wolf and brown bear) in the Beskydy stems from the data collected through the field monitoring of large carnivores carried out by experts and volunteers in Beskydy PLA (Kutal & Bláha 2008). In 2003–2011, the presence of large carnivores was detected mainly by snow-tracking sessions, taking place across selected parts of the study area. At other times without snow cover, only footprints in mud and scat on forest roads were recorded. During the time of continuous snow cover, animals were backtracked when possible (Jedrzejska et al. 1996; Smietana & Wajda 1997; Swenson & Wikan 1996). Due to the voluntary nature of field work in the mountainous area, no regular transects were set and also the number of walked trails in the area covered by monitoring changed over the study period. Therefore, a system of monitoring intensity was also taken into account. We used the 10 × 10 km European Environment Agency (EEA) grid system for the evaluation of monitoring intensity and species occurrence. A square was considered to be covered by monitoring, if it was crossed at least 12 walking transects for a minimum length of 2 km during the study period. Monitoring intensity was expressed either as the total number of trails in different squares conducted in different days (“square-days”, Table 2) or as the number of trails crossing a square (Fig. 4). In both cases additional trails crossing a square within the same day were excluded to avoid double counting of parts of trails walked by more than one group during same day. Because some trails crossed more than one square, a total number of 1851 walked trails resulted in 2382 square-days. The size of the monitored area was calculated as an area of squares monitored each year (Table 2). The reliable data of large carnivore signs were included in the analysis. We used indices of carnivores’ signs found in different days and different squares – how many square-days were “positive” in terms of large carnivore occurrence. The correlation between monitoring intensity and species occurrence in individual squares in each year was calculated using Spearman correlation coefficient.

All three species of large carnivores in the Beskydy Mountains are protected by the Nature and Landscape Protection Act and sheep farmers are entitled to financial compensation for damage caused by large carnivores (Stejskal 2006). Registered data documenting the cases of attacks on sheep by large carnivores from 2001, as well

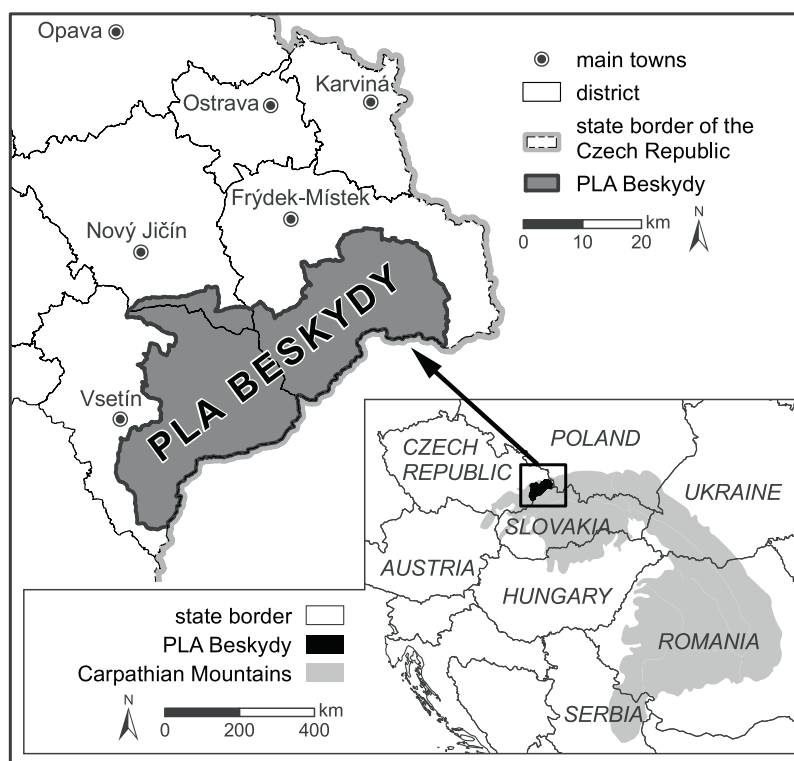


Fig. 1. Study area (PLA Beskydy).

as compensation to sheep farmers were obtained from databases of regional authorities in the Moravian-Silesian Region (hereinafter referred to as MSR) and the Zlín Region (hereinafter referred to as ZR), and from unpublished archival data of the Administration of Beskydy PLA.

In order to test whether large carnivores are a limiting factor for sheep breeding in the Beskydy region, a questionnaire-based survey involving a representative sample of 112 individual sheep farmers was completed. The survey was conducted over a period of four months, from February to May 2012. In order to obtain unbiased data, we concentrated on dichotomous fact-finding items when designing the questionnaires, whereas the items identifying the views and attitudes of respondents were constructed as so-called masked questions (Peers 1996). Interviews were conducted locally with questionnaires completed at the respondents place of residence, by the interviewer.

To determine a reliability degree of questionnaire-based survey results, we applied a method based on a comparison of results obtained in two equal samples which originated as a representative selection from the basic sample (Howell 2009; Rosner 2011). The concordance rate (overlap) between the responses of respondents in both randomly generated samples was expressed using Cohen's coefficient (Cohen 1960; Cohen et al. 2007). The calculated value (0.812) can be considered satisfactory in terms of concordance and the value of the standardised normal variable (6.21) indicates a statistically significant concordance between respondent answers at the significance level of 0.01.

Results

Current status of sheep breeding in the Beskydy Mountains

Within the entire area of the three selected districts (Vsetín, Nový Jičín and Frýdek-Místek), a total of 19 896 sheep were held on 1770 farms. Each farm was registered officially as per December

31, 2011 (Table 1). The largest number of farms (792) was registered in the district of Frýdek-Místek, while most sheep were kept in the district of Vsetín (9 171 sheep which accounted for 46% of the total number of sheep kept in the area).

According to the questionnaire-based survey results, the number of sheep farmed varied from 11 to 50 sheep per breeder (64%), far less breeders owned 1–10 sheep (24%) or more than 50 sheep (12%). The area of managed pastures per farmer ranged from 1 to 204 hectares. Most of the sheep farmers (71%) managed less than 10 ha of pastures, only 17% of farmers managed 11–20 ha, and 12% of farmers managed more than 20 ha. The questionnaire-based survey results showed that 83% of current sheep farmers in the Beskydy were over 50 years of age (Fig. 2). Young people under 30 were absent and people aged 30–50 represented only 17% of farmers. The analysis of educational attainment (Fig. 3) indicated that

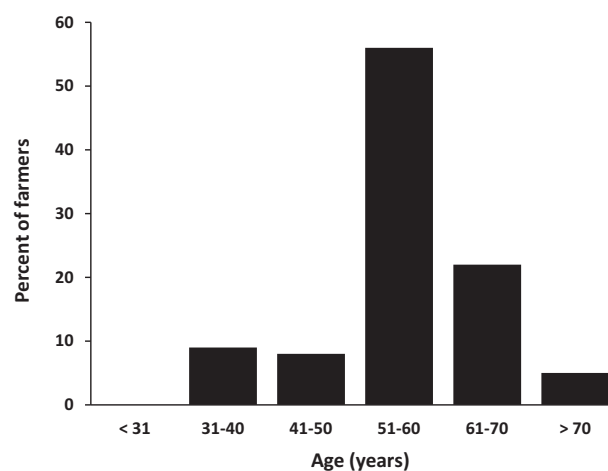


Fig. 2. Age structure of sheep farmers in the Beskydy area ($n = 112$).

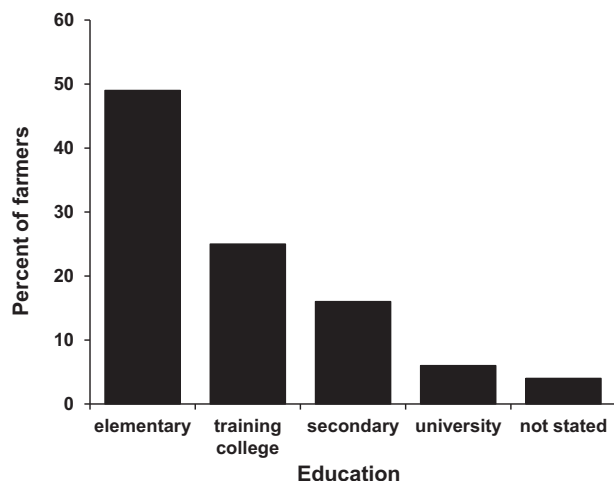


Fig. 3. Educational structure of sheep farmers in the Beskydy region ($n = 112$).

almost half of the sheep farmers had only basic education and only 6% of them had university education.

Presence of large carnivores in the Beskydy Mountains

Grey wolf (*Canis lupus*)

Official monitoring of the presence of wolves started in 2003. Since this time, the occurrence of wolves in the Beskydy area was considered to be sporadic and probably limited to only a few individual wolves or small groups of wolves straying into Beskydy from Slovakia or Poland (Table 2). Observed sightings of their occurrence were scattered throughout the Beskydy area except for the border with Slovakia around Little and Great Javorník (Fig. 4a), where wolves were repeatedly detected in 2007.

Eurasian lynx (*Lynx lynx*)

The Eurasian lynx was recorded as the most abundant of the three studied species of large carnivores occurring in the Beskydy region. A persisting lynx population continues to exist in this territory (Table 2). The indices of lynx observations grew steadily from 2003 until 2011 but this growth was probably mainly caused by increased monitoring intensity ($R = 0.534$, $p = 0.05$). Lynxes were detected throughout a large part of monitored area (Fig. 4b).

Brown bear (*Ursus arctos*)

Since 2003, the occurrence of brown bear in the Beskydy Mountains was exceptional. The number of bear detections for the whole monitoring period ranged from 0 to 3 per year (Table 2). Thus, the number of bears in the Beskydy Mountains (and the entire Czech Republic) has probably been minimal (close to zero) since 2003. With regard to the possibility of bear attacks on farmed sheep in the Beskydy, the occurrence of bears was negligible.

Conflicts between large carnivores and sheep breeding

Over the entire monitored period (2001–2012), sheep were the most likely target of attacks by large carnivores (91.8%), whereas there was only a small percentage of recorded attacks on goats (3.5%) and calves (4.7%). The number of attacks by large carnivores on farmed sheep in the Beskydy strongly varied between individual years and ranged from 0 to 16 cases per year (Fig. 5). The number of wolf attacks per year decreased significantly during the period 2001–2012 ($r = -0.62$, $p = 0.03$). This decrease was evidenced by a distinct decrease in the district of Frýdek-Místek ($r = -0.80$, $p = 0.002$), whereas in the district of Vsetín there was

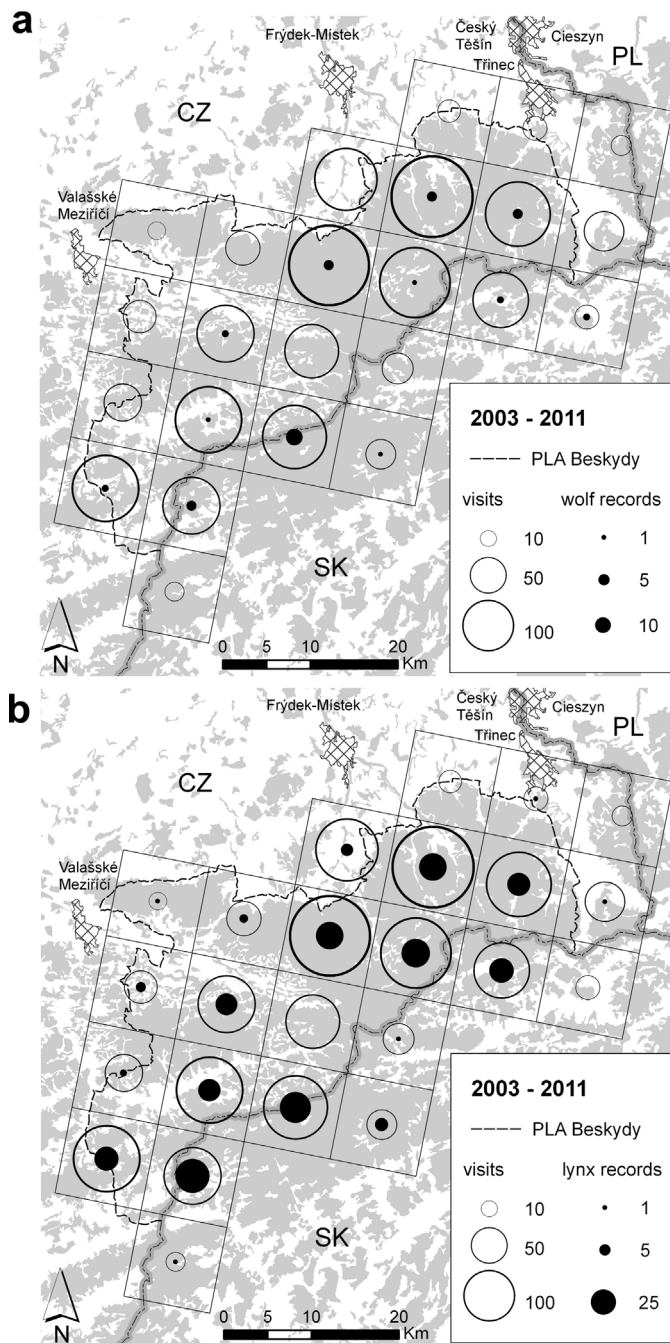


Fig. 4. Map of the occurrence rate of the wolf (*Canis lupus*) (a) and the Eurasian lynx (*Lynx lynx*) (b) in the Beskydy Mountains in 2003–2011 (the size of black circles corresponds to the number of the records of wolves 0–12 and lynxes 1–46); the size of grey circles corresponds to monitoring intensity in the individual mapping squares (12–257 visits).

no significant trend ($r = 0.01$, $p = 0.97$). The total number of sheep attacked within the monitored period ranged from 0 (2009) to 58 (2004) per year; an average of $16.3 (\pm 14.5)$ sheep were attacked each year.

The importance of the three species of carnivores in terms of damage caused to farmed sheep differed strongly (Table 3). According to MSR and ZR databases, the greatest damage to farmed sheep was caused by wolves (93.7% of attacks on sheep by large carnivores). Eurasian lynx, although being clearly the most abundant large carnivore in the Beskydy Mountains, was identified as the attacker in only one case (1.3%, see Fig. 5). Brown bear was also

Table 3

Number of reported attacks on farmed sheep in the Beskydy region during the period from 2001 to 2012 by attacking carnivores and by single districts.

Attacking carnivore	Number of attacks by district			Total number of attacks	Number of attacked sheep by district			Total number of attacked sheep
	Vsetín	Frýdek-Místek	Nový Jičín		Vsetín	Frýdek-Místek	Nový Jičín	
Wolf	41	32	1	74	111	78	1	190
Eurasian lynx	1	0	0	1	2	0	0	2
Brown bear	3	1	0	4	3	1	0	4
Total	45	33	1	79	116	79	1	196

relatively rare attacker – only four attacks upon domestic animals (5.0%) were registered.

Most attacks on sheep were recorded in two regions: the Moravskokolezské Beskydy located in Frýdek-Místek district (41.8% attacks); and, the Vsetínské Hills and Javorníky hills in Vsetín district (56.9%). Only one attack was recorded in the district of Nový Jičín (1.3%).

The comparison between the total number of attacks on sheep by large carnivores (79) with the total number of farms in the area of Frýdek-Místek and Vsetín (1370) districts and the total number of farmed animals (16,138) shows that attacks were recorded in only 0.48% of farms in the region per year (5.8% of farms per 12 year monitoring period). The average number of attacked animals per year (16.3) represents 0.1% of the total number of farmed animals in the region.

Sheep breeding in the Beskydy area in the context of the presence of large carnivores as viewed by farmers

Within the questionnaire-based survey, most farmers (90%) indicated that sheep breeding in the Beskydy region is currently uneconomic and without profit. The respondents mentioned the following three major negative economic factors (in order of their relative importance): (1) low purchase prices of sheep products; (2) little demand for these products; and, (3) the distance of sheep-breeding sites from slaughterhouses (often more than 50 km). The presence of large carnivores was described as a fourth negative factor affecting the economics of sheep breeding.

Sheep breeding was mostly regarded as a side interest of farmers (73% of respondents); they bred sheep mainly because of family tradition, for their own use or as a hobby. Almost two thirds of the respondents failed to answer the question regarding the minimum required acreage for grazing sheep to make their breeding economically profitable. A minimum number of 14 sheep per farmer was considered to be a key economic issue to maintain breeding (76% of

respondents) – lower numbers of sheep per farmer do not provide subsidies.

Most sheep breeders in the Beskydy region (79%) used flat subsidies for sheep breeding (national additional top-up payments – per livestock unit) and for management of agricultural land registered per applicant in a public register of land (SAPS payment – per area). Sheep farmers were provided with these subsidies in a uniform manner throughout the Czech Republic, regardless of the specific conditions of the breeding site. The fact that the presence of large carnivores was not taken into account and that active measures to protect sheep against attacks by large predators were not financially supported was felt by the majority of respondents (92%) to disadvantage farmers in the Beskydy region.

In addition to agricultural subsidy programmes and under certain conditions, some sheep farmers might also obtain funds to support sheep breeding within the landscape-shaping programmes of the Ministry of Environment (namely the Landscape cultivation programme and Programme for restoring natural landscape functions). Nevertheless, financial resources in the landscape-shaping programmes were directed solely for the purpose of the support of land maintenance in the most ecologically valuable parts of the Beskydy Mountains and most respondents (88%) stated that they cannot acquire this financial contribution because the respective areas are located beyond their farms.

According to the questionnaire-based survey results, the attitude of sheep breeders towards the presence of large carnivores was negative. Most farmers were concerned by the occurrence of large carnivores (43% of respondents) or took the position of “when they are not here, I do not mind” (23% of respondents). A smaller portion of respondents (23%) did not object to large carnivores and only a few respondents (7%) enjoyed their presence (Fig. 6). Most sheep breeders (66%) agreed with the statement that the presence of large carnivores poses a real danger to sheep.

Many respondents (47%) were convinced that the optimum solution to attacks on farmed sheep by large carnivores should be in the form of financial compensation for livestock losses. More than 43% of farmers would solve this problem by eradicating the large carnivores and only 20% of them consider better technical and organisational measures for the protection of sheep herds against possible attacks to be the optimal solution.

A small portion of respondents (23%) did not know any technical and organisational measures for the protection of sheep herds, however, most farmers (77%) did. As regards particular measures, they preferred electric fences (57%), trained herding dogs (47%) and enclosing the farmed sheep in secured facilities at night (23%).

Discussion

Sheep farming in the Beskydy region

The obtained data suggests that traditional sheep farming is still practised in large numbers in the Beskydy region. However, from the perspective of farmers, sheep breeding in the Beskydy region is not economically profitable and the interest in sheep

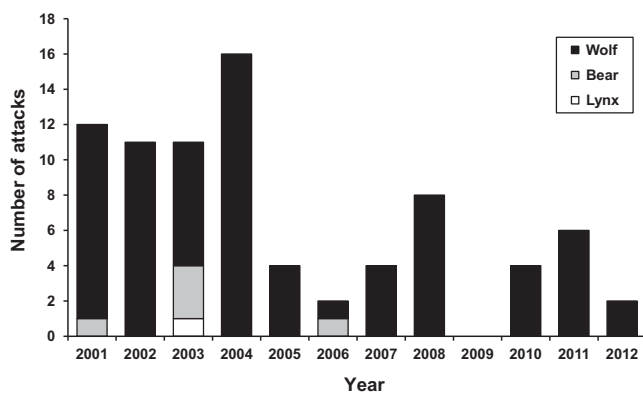


Fig. 5. Frequency of reported and compensated attacks by large carnivores on sheep within the Beskydy region (source: MSR and ZR databases, Administration of Beskydy PLA database).

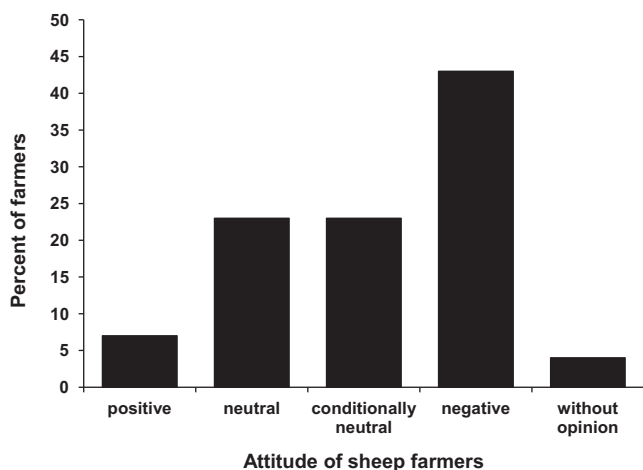


Fig. 6. Attitude of sheep farmers towards the occurrence of large carnivores in the Beskydy region ($n = 112$). Categorization of attitudes: (1) positive (the breeder is pleased by the occurrence of carnivores in the region), (2) neutral (the breeder does not care about the occurrence of carnivores in the region), (3) conditionally neutral (the breeder does not care as long as the predators are not close), (4) negative (the breeder is bothered by the occurrence of carnivores in the region), (5) without opinion.

breeding among young people under 30 and people with education higher than elementary school is currently very small; this statement is sustained also by experience from other European regions (Dýrmundsson 2006). In the relative order of factors that negatively affect the economics of sheep breeding in the Beskydy region, low purchase prices of sheep products, little demand for these products and the considerable distance of sheep-breeding sites from slaughterhouses are the most important. The hypothesis that large carnivores can be a limiting factor for sheep grazing management of landscape in the Beskydy region was not confirmed – the presence of large carnivores was mentioned only as insignificant, after crucial economic factors. The results correspond to experience from other countries (Berger 2006; Kaczensky 1996).

Sheep breeding should be preserved primarily by support of local sheep products using economic tools (advantage for local products over imported products, subsidies to local breeders, support of agritourism etc.), by facilitation of necessary education and information acquisition and by reinforcing the good reputation of local breeders and their products. The importance of sheep grazing for nature conservation in the Beskydy region should be also accentuated and incorporated into the social prestige of farmers (see De Snoo et al. 2013).

Large carnivores in the Beskydy region and their conflicts with sheep breeding

The economic impact of large carnivores is regarded as low, as stated by farmers, and this could correspond with the results of our monitoring exercise of large carnivores and their conflicts with sheep breeding. The results indicate that the populations of wolves and bears in the Beskydy are very low; their indices fluctuated close to zero during the monitoring period and their occurrence was probably dependent on migrants from Slovakia. Kunc (1998) states that wolves can settle down in the Beskydy only when the territories in Slovakia are saturated. According to Kunc and Bartošová (2005), poaching of carnivores is also an important reason for their low population in the Czech Republic and many animals were shot in the past (Sajdl 2000), including the first small population of wolves originating in the border area between the Czech Republic and Slovakia in 1995–1996 that subsequently disappeared in 1997 (Bartošová 1998; Kunc 1998). The lynx showed

a stable occurrence during the study period, and its distribution throughout the Beskydy area corresponds to the results of previously published studies (Anděra & Červený 2009; Červený et al. 1996).

The importance of the three species of carnivores in terms of conflicts with sheep breeding differs and depends on the habits of the particular species and local husbandry traditions (Kaczensky 1999). The Eurasian lynx, although being clearly the most abundant large carnivore in the Beskydy, attacked domestic animals only on the rarest of occasions. In other regions, the role of the lynx in predation on domestic sheep is also less important but the frequency of attacks is much higher in some regions (Kaczensky 1996), especially in Scandinavia (Odden et al. 2002; Warren & Mysterud 1990). Brown bears attacked sheep rarely in our study area but, in contrast to the lynx, this species is very rare in the Beskydy region. A potential risk for farmed sheep may be occasionally represented by young or disabled individual bears from Slovakia (Červený & Koubek 2003). Most attacks were caused by wolves, or, more precisely, by canids. The dominant role of wolves in attacks on domestic animals was also confirmed in other studies from the Carpathian areas where all three large carnivores reside (Kaczensky 1996; Nowak & Mysłajek 2004; Rigg et al. 2011). Nevertheless, as the wolf has been very rare in the Beskydy region in recent years and its population has probably been formed by errant animals from Slovakia or Poland, the frequency of wolf attacks on sheep was also very low and during the period 2001–2012 it declined even further. The decline of wolf attacks seems to be in concordance with the decline of the occurrence of wolves in the Beskydy region in recent years (even if intensity of monitoring was growing) and could be in relation to continuous poaching of large carnivores and also to the ongoing annual authorisation of hunting of important parts of the wolf population in Slovakia (Rigg 2007).

Generally, the low numbers of registered attacks on domestic animals in the Beskydy region implies that predation by large carnivores is of little importance. Similarly, in several European countries where large carnivores occur, the claims due to predation represent less than 1% of available livestock (Kaczensky 1996). Moreover, based on the ten-year field monitoring of this issue, we conclude that recorded attacks on sheep could be partly caused by large stray dogs (Ciucci & Boitani 1998). This consideration is also supported by sheep farmers' statements – in the questionnaire-based survey 30% of respondents reported that they experienced problems with stray dogs endangering their farmed sheep. Distinguishing the residential marks of a wolf and a dog of the same size is often very difficult or, in some cases, even impossible (Anděra & Horáček 2005; Bang et al. 1974), and confusion between dogs and wolves therefore cannot be excluded without a genetic evidence (Sundqvist et al. 2008). Wolf-dog hybrids can also be the source of problems for livestock protection (Randi 2011), but they were not confirmed during a preliminary genetic study in the West Carpathians that included our study area (Hulva et al. 2013).

Attitude of farmers towards large carnivores, compensations and subsidies

Although the frequency of attacks in the period from 2001 to 2012 was very low, most breeders evaluate the presence of large carnivores in the Beskydy area as a real threat to sheep. The negative attitude of farmers towards large carnivores is common also in other areas in Europe (Graham et al. 2005; Kaltenborn et al. 1999; Røskaft et al. 2007; Rigg et al. 2011) and increases with the increasing age of farmers and their decreasing educational level (Bjerke et al. 1998; Røskaft et al. 2007). Important factors supporting the preservation of sheep breeding in the presence of large carnivores, as perceived by sheep farmers, include financial compensation for damage resulting from attacks on sheep by large predators.

Therefore, compensation should be maintained in the future even though it has some limitations (Cozza et al. 1996; Montag 2003; Swenson & Andrén 2005) and often does not change the attitude of people towards the carnivores (Naughton-Treves et al. 2003). A subsidy for the protection of domestic animals against possible attacks by predators (herding dogs, technical measures) could also be a suitable form of support for farmers in areas with large carnivores. The losses caused by large carnivores could be minimised by preventive measures (guarding dogs, electric fences, enclosing sheep at night etc., see Rigg 2010). Sheep flocks in Slovakia guarded by dogs were predated 70% less than control flocks without preventive measures (Rigg et al. 2011).

Sheep breeders in the Beskydy region mostly use flat subsidies for sheep breeding and management of agricultural land; effectiveness of landscape-shaping programmes (Landscape cultivation programme and Programme for restoring natural landscape functions) is restricted to the most ecologically valuable parts of the Beskydy Mountains (Zone I of the protected landscape area, nature reserves and sites of the European system Natura 2000; see Miko & Borovičková 2007) because financial resources in the programmes are limited. Nevertheless, most farmers stated that they cannot acquire this financial contribution because the respective areas are located far from their farms. It has become a big problem for landscape protection because sheep grazing in these areas was the main method of maintaining active care of non-forests biotopes (Petříček 1999) and it has an irreplaceable role for protection of the biodiversity (Šarapatka & Niggli 2008; Weissmannová 2004). The importance of grazing management for meadows and pastures in the area of Beskydy Mountains was described by Spitzer et al. (2011) with an example of the local population of the critically endangered large blue butterfly (Phengaris arion). Termination of grazing and subsequent successional overgrowing of biotopes leads to the loss of diversity of farmland birds (Šťastný et al. 2004) and also threatens a number of other biological species (Benton et al. 2003).

Moreover, in principle, biologists agree that solutions for maintaining the biodiversity of non-forest biotopes has neither been solved by European agroenvironmental programmes (Kleijn et al. 2001) nor organic agriculture (Bengtsson et al. 2005; Hole et al. 2005). These programmes may enable the maintenance of mowing meadows and grazing sheep in the countryside (Bignal & McCracken 1996) but are administratively configured to support homogenisation of care for habitats on large areas and thus prevent the creation of a much needed small landscape mosaic (Ausden 2007). From this point of view, the optimum solution for maintaining biodiversity is to sustain the grazing of sheep (Bignal & McCracken 1996; Metera et al. 2010) by breeders who unintentionally create a diverse mosaic of pasture and hay meadows in various overlapping stages of grassland development through small-scale landscape management (Weibull et al. 2000, 2003).

Conclusions

The occurrence of large carnivores, especially of the most important species – the grey wolf, is sporadic in the Beskydy region and the attacks on sheep by carnivores are even rarer. In comparison to the number of attacks with the total number of farms and farmed animals shows that the occurrence of large carnivores is a minor problem for sheep grazing. The economic sustainability of sheep breeding is a more important issue for the farmers. Because sheep grazing has an essential role in the protection of biodiversity of the Carpathian landscape, local sheep farmers and their products should be supported using economic tools and appropriate education. Besides, it is still important to maintain general measures to support grazing in important natural areas, or even better to adapt

them to the needs of farmers – improve the availability and simplify administration of financial allowance or taxation advantages for local breeders.

Although the claims due to predation by large carnivores on sheep are of little importance, the financial compensation for damage resulting from attacks on livestock should be preserved and the support for livestock protection (trained herding dogs, electric fences) should be implemented. They are important for the reduction of negative attitudes of farmers to large predators, but should be related with simultaneous education of farmers (and other local people) in ecology and importance of large carnivores.

Acknowledgment

We are grateful to many volunteers participating in the large carnivore monitoring in the Beskydy area, especially to Leona Machalová, Michal Bojda, Martin Váňa, Martin Janča and Petr Mohyla, for their field work and to Michal Bojda and Vendula Burdová for their work on the questionnaire-based survey. We are indebted to two anonymous reviewers for their valuable comments and suggestions and Lenka Šikulová and James Milne for English corrections. We would also like to thank the Ministry of Agriculture of the Czech Republic, Regional authorities of the Moravian-Silesian and Zlín Regions and the Administration of the Beskydy Protected Landscape Area for the data provided. The work on this paper was supported by a grant from Palacký University in Olomouc, ENVIRUP No. CZ.1.07/2.2.00/07.0086. The monitoring of large carnivores in the Beskydy Mountains was supported by the Internal Grant Agency of Faculty of Forestry and Wood Technology of Mendel University in Brno, Project No. 1/2012, by grants from Financial Mechanisms of EEA and Norway, from Switzerland through the Swiss Contribution to the enlarged European Union, from the Ministry of Environment of the Czech Republic and from the Palacký University in Olomouc, KONEV No. CZ.1.07/2.4.00/17.0073.

References

- Anděra, M., & Červený, J. (2009). *Large mammals in the Czech Republic. Distribution, history and protection. 2. Carnivores (Carnivora)*. Prague: National Museum.
- Anděra, M., & Horáček, I. (2005). *Poznáváme naše savce*. Praha: Sobotáles.
- Ausden, M. (2007). *Habitat management for conservation*. Oxford: Oxford University Press.
- Bang, P., Dahlström, P., & Vevers, G. (1974). *Collins guide to animal tracks and signs: The tracks and signs of British and European mammals and birds*. London: Harper-Collins Publishers Limited.
- Bartošová, D. (1998). *Osud vlků v Beskydech je nejistý*. *Veronica*, 11, 1–7.
- Bengtsson, J., Ahnström, J., & Weibull, A. C. (2005). The effects of organic agriculture on biodiversity and abundance: A meta-analysis. *Journal of Applied Ecology*, 42, 261–269.
- Benton, T. G., Vickery, J. A., & Wilson, J. D. (2003). Farmland biodiversity: Is habitat heterogeneity the key? *Trends in Ecology and Evolution*, 18, 182–188.
- Berger, K. M. (2006). Carnivore-livestock conflicts: Effects of subsidized predator control and economic correlates on the sheep industry. *Conservation Biology*, 20, 751–761.
- Bignal, E. M., & McCracken, D. I. (1996). Low-intensity farming systems in the conservation of the countryside. *Journal of Applied Ecology*, 33, 413–424.
- Bjerke, T., Reitan, O., & Kellert, S. R. (1998). Attitudes toward wolves in southeastern Norway. *Society and Natural Resources*, 11, 169–178.
- Chytrý, M., Kučera, T., Kočí, M., Grulich, V., & Lustyk, P. (2010). *Katalog biotopů České republiky (2nd ed.)*. Praha: AOPK ČR.
- Ciucci, P., & Boitani, L. (1998). Wolf and dog depredation on livestock in central Italy. *Wildlife Society Bulletin*, 26, 504–514.
- Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, 41, 687–699.
- Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education*. New York: Taylor & Francis e-Library.
- Cozza, K., Fico, R., Battistini, M. L., & Rogers, E. (1996). The damage-conservation interface illustrated by predation on domestic livestock in central Italy. *Biological Conservation*, 78, 329–336.
- Červený, J., & Koubek, P. (2003). The brown bear in the Czech Republic. In B. Krystufek, B. Flajsman, & H. I. Griffiths (Eds.), *Living with bears: A large European carnivore in a shrinking world* (pp. 245–257). Ljubljana: Ecological Forum of the Liberal Democracy of Slovenia.

- Červený, J., Koubek, P., & Anděra, M. (1996). Population development and recent distribution of the lynx (*Lynx lynx*) in the Czech Republic. *Acta Scientiarum Naturalium Brno*, 30, 2–15.
- Demek, J. (1987). *Zeměpisný lexikon ČSR. Hory a nížiny*. Praha: Academia.
- Dýrmondsson, Ó. R. (2006). Sustainability of sheep and goat production in North European countries – From the Arctic to the Alps. *Small Ruminant Research*, 62, 151–157.
- Graham, K., Beckerman, A. P., & Thirgood, S. (2005). Human–predator–prey conflicts: Ecological correlates, prey losses and patterns of management. *Biological Conservation*, 122, 159–171.
- Halladay, D., & Gilmour, D. A. (1995). *Conservation biodiversity outside protected areas. The role of traditional agro-ecosystems*. Gland: IUCN.
- Hole, D. G., Perlina, A. J., Wilson, J. D., & Alexander, I. H. (2005). Does organic farming benefit biodiversity? *Biological Conservation*, 122, 113–130.
- Howell, D. C. (2009). *Statistical methods in psychology*. Belmont: Wadworth Cengage Learning.
- Hulva, P., Bolříková, B., Říhová, J., Smetanová, M., & Kutal, M. (2013). Landscape genetics of the grey wolf in the Western Carpathian Mountains. In M. Kutal (Ed.), *Large carnivores and migration corridors in the Western Carpathians: Malá Fatra–Kysucké Beskydy–Moravskoslezské Beskydy–Javorníky* (pp. 4–53). Olomouc: Friends of the Earth Czech Republic–Olomouc branch.
- Jedrzejewska, B., Jedrzejewski, W., Bunevich, A. N., Milkowski, L., & Okarma, H. (1996). Population dynamics of wolves *Canis lupus* in Białowieża Primeval Forest (Poland and Belarus) in relation to hunting by humans, 1847–1993. *Mammal Review*, 26, 103–126.
- Kaartinen, S., Luoto, M., & Kojola, I. (2009). Carnivore–livestock conflicts: Determinants of wolf (*Canis lupus*) depredation on sheep farms in Finland. *Biodiversity and Conservation*, 18, 3503–3517.
- Kaczynski, P. (1996). *Livestock–carnivore conflicts in Europe*. Munich: Munich Wildlife Society.
- Kaczynski, P. (1999). Large carnivore depredation on livestock in Europe. *Ursus*, 11, 59–72.
- Kaltenborn, B. P., Bjerke, T., & Vittersø, J. (1999). Attitudes toward large carnivores among sheep farmers, wildlife managers, and research biologists in Norway. *Human Dimensions of Wildlife*, 4, 57–73.
- Kleijn, D., Berendse, F., Smit, R., & Gillissen, N. (2001). Agri–environment schemes do not effectively protect biodiversity in Dutch agricultural landscapes. *Nature*, 413, 723–725.
- Krahulec, F., Hadincová, V., Freiová, R., Herben, T., Pecháčková, S., & Skálová, H. (2001). Vegetation changes following sheep grazing in abandoned mountain meadows. *Applied Vegetation Science*, 4, 97–102.
- Kunc, L. (1998). K výskytu vlků v Moravskoslezských Beskydech. *Veronica*, 11, 8–11.
- Kunc, L., & Bartošová, D. (2005). Patří velké šelmy do Beskyd? *Živa*, 92, 37–40.
- Kutal, M., & Bláha, J. (2008). A public awareness campaign as part of a management plan for large carnivores in the Czech Republic, current conservation activities and problems. In M. Kutal, & R. Rigg (Eds.), *Perspectives of wolves in Central Europe: Proceedings from the conference 9 April 2008, Malenovice, Beskydy Mts., Czech Republic*, (pp. 11–14). Olomouc: Hnutí DUHA Olomouc.
- Martinát, S., Klapka, P., & Nováková, E. (2008). Changes of spatial differentiation in livestock breeding in the Czech Republic after 1990. *Contemporary changes of agriculture in East-Central Europe*, 97–120.
- Meriggi, A., & Lovari, S. (1996). A review of wolf predation in southern Europe: Does the wolf prefer wild prey to livestock? *Journal of Applied Ecology*, 33, 1561–1571.
- Metera, E., Sakowski, T., Słoniewski, K., & Romanowicz, B. (2010). Grazing as a tool to maintain biodiversity of grassland – A review. *Animal Science Papers and Reports*, 28, 315–334.
- Miko, L., & Borovičková, H. (Eds.). (2007). *Zákon o ochraně přírody a krajiny Komentář*. Praha: C. H. Beck.
- Montag, J. (2003). Compensation and predator conservation: Limitations of compensation. *Carnivore Damage Prevention News*, 6, 2–6.
- Naughton-Treves, L., Grossberg, R., & Treves, A. (2003). Paying for tolerance: Rural citizens' attitudes toward wolf depredation and compensation. *Conservation Biology*, 17, 1500–1511.
- Niznikowski, R., Strzelec, E., & Popielarczyk, D. (2006). Economics and profitability of sheep and goat production under new support regimes and market conditions in Central and Eastern Europe. *Small Ruminant Research*, 62, 159–165.
- Nowak, S., & Mysłajek, R. W. (2004). Livestock guarding dogs in the western part of the Polish Carpathians. In *Carnivore Damage Prevention News, January Edition*.
- Odden, J., Linnell, J. D. C., Moa, P. F., Herfindal, I., Kvam, T., & Andersen, R. (2002). Lynx depredation on domestic sheep in Norway. *The Journal of Wildlife Management*, 66, 98–105.
- Pavelka, J., & Trezner, J. (Eds.). (2001). *Příroda Valašska (okres Vsetín)*. Vsetín: ČSOP.
- Peers, I. (1996). *Statistical analysis for education and psychology researchers*. London: Falmer Press.
- Petříček, V. (Ed.). (1999). *Pěče o chráněná území I Nelesní společenstva*. Praha: AOPK ČR.
- Randi, E. (2011). Genetics and conservation of wolves *Canis lupus* in Europe. *Mammal Review*, 41, 99–111.
- Rigg, R. (2007). Početnost, odstrel a ochrana vlka dravého (*Canis lupus*) v slovenských Karpatoch–príveľ a či málo? In M. Adamec, P. Urban, & M. Adamcová (Eds.), *Výskum a ochrana cicavcov na Slovensku VIII. Zborník referátov z konferencie (Zvolen 12–13 10 2007)* (pp. 200–2130). Banská Bystrica: Štátna ochrana prírody SR.
- Rigg, R. (2010). *Pasteveční psi. Praktická příručka pro chovatele ovcí a koz*. Olomouc: Hnutí Duha.
- Rigg, R., Findo, S., Wechselberger, M., Gorman, M. L., Sillero-Zubiri, C., & McDonald, D. W. (2011). Mitigating carnivore–livestock conflict in Europe: Lessons from Slovakia. *Oryx*, 45, 272–280.
- Rosner, B. A. (2011). *Fundamentals of biostatistics*. Boston: Cengage Learning.
- Røskoft, E., Händel, B., Bjerke, T., & Kaltenborn, B. P. (2007). Human attitudes towards large carnivores in Norway. *Wildlife Biology*, 13, 172–185.
- Sajdl, M. (2000). Vlk v Moravskoslezských Beskydech. In Anonymous (Ed.), *Predátoři v myslivosti 2000 Sborník referátů z celostátní conference, Hranice* (pp. 115–121). Česká lesnická společnost: Dobříš.
- Smietana, W., & Wajda, J. (1997). Wolf number changes in Bieszczady National Park, Poland. *Acta Theriologica*, 42, 241–252.
- De Snoo, G. R., Herzon, I., Staats, H., Burton, R. J. F., Schindler, S., van Dijk, J., et al. (2013). Toward effective nature conservation on farmland: Making farmers matter. *Conservation Letters*, 6, 66–72.
- Spitzer, L., Beneš, J., & Konvička, M. (2011). Valašská krajina a modrásek černoskvrný. *Živa*, 59, 176–179.
- Stejskal, V. (2006). *Úvod do právní ochrany přírody a péče o biologickou rozmanitost*. Linde: Praha.
- Sundqvist, A.-K., Ellegren, H., & Vilà, C. (2008). Wolf or dog? Genetic identification of predators from saliva collected around bite wounds on prey. *Conservation Genetics*, 9, 1275–1279.
- Swenson, J. E., & Andrén, H. (2005). A tale of two countries: Large carnivore depredation and compensation schemes in Sweden and Norway. In R. Woodroffe, S. Thirgood, & A. Rabinowitz (Eds.), *People and wildlife: Conflict or coexistence?* (pp. 323–339). London: Cambridge University Press.
- Swenson, J. E., & Wikan, S. (1996). A brown bear population estimate for Finnmark County, North Norway. *Fauna Norvegica Series A*, 17, 11–15.
- Šarapatka, B., & Niggli, U. (2008). *Zemědělství a krajina: cesty k vzájemnému souladu*. Olomouc: Palacký University.
- Šťastný, K., Bejček, V., Voříšek, P., & Flousek, J. (2004). Population trends of birds in forest and agricultural landscape in the Czech Republic in 1982–2001 and its use as bioindicators. *Sylvia*, 40, 27–48.
- Warren, J. T., & Mysterud, I. (1990). Domestic sheep mortality on a forested Norwegian range. *Transactions of the International Union of Game Biologists Congress*, 19, 605–612.
- Weibull, A. C., Bengtsson, J., & Nohlgren, E. (2000). Diversity of butterflies in the agricultural landscape: The role of farming system and landscape heterogeneity. *Ecography*, 23, 743–750.
- Weibull, A. C., Östman, Ö., & Granqvist, Å. (2003). Species richness in agroecosystems: The effect of landscape, habitat and farm management. *Biodiversity and Conservation*, 12, 1335–1355.
- Weissmannová, H. (2004). Ostravsko. In P. Mackovčín, & M. Sedláček (Eds.), *Chráněná území ČR*. Praha: AOPK ČR, EkoCentrum Brno.