Earthscan Studies in Natural Resource Management

earthscan from Routledge

Large Carnivore Conservation and Management

Human Dimensions

Edited by Tasos Hovardas

Considering wolves as active agents in understanding stakeholder perceptions and developing management strategies

Nicolas Lescureux[1], Laurent Garde[2] & Michel Meuret[3]

1. Centre National de la Recherche Scientifique (CNRS)
Centre d'Ecologie Fonctionnelle et Evolutive (CEFE), CNRS, Univ Montpellier, UPV Montpellier 3, EPHE, IRD
1919 Route de Mende, 34 293 Montpellier, France

2. Centre d'Etude et de Réalisation Pastorale Alpes Méditerranée (CERPAM)
570, avenue de la Libération, 04 100 Manosque, France

3. Institut National de la Recherche Agronomique (INRA)
UMR Systèmes d'Elevage Méditerranéens et Tropicaux (SELMET)
2 Place Pierre Viala, 34 060 Montpellier, France

Abstract

Until recently, the diversity of human-wolves relationships and the associated conflicts have mainly been explained through the various socio-cultural contexts. The agency of wolves, notably their ability to adapt their behaviour to human practices, has been underestimated and so the intrinsic dynamic dimension of the relationships.

Indeed, our surveys in several countries (Republic of Macedonia, Kyrgyzstan, France) showed that radical changes in husbandry or hunting practices have led to modifications in the socio-environmental context and the nature of human-wolf interactions, resulting in apparent changes in wolves' behaviours. These changes have often resulted in an increased vulnerability of local people to wolf damages, a reduced acceptance for wolves and increasing conflicts, even in countries where humans and wolves have continuously coexisted. Therefore, the diversity of human-wolf relationships is not only the result of various socio-cultural contexts but also emerges in diverse historical trajectories that engage both humans and wolves in specific social and ecological contexts.

Considering wolves as active agents in the relationships appears necessary to understand conflicts and adopt appropriate management strategies, not only based on damage prevention but also implying direct pressure on wolves to make coexistence conceivable.

Keywords: Canis lupus, stakeholder perception, adaptation, dynamic relationships, historical trajectories, animal agency, predator control

This is an edited author's version of the chapter:

Lescureux, N., L. Garde, and M. Meuret. 2018 *Considering wolves as active agents in understanding stakeholders perceptions and developing management strategies*, in Large Carnivore Conservation and Management. Human Dimensions, T. Hovardas, Editor. Routledge: London. p. 147-167.

Introduction

Humans and grey wolves (*Canis lupus*) have been sharing the same landscape, the same habitats and even some similarities in their hunter's way of life for a long time (Olsen 1985, Clutton-Brock 1995). However, it is quite probable that the domestication of ungulate species (cattle, sheep and goat), which started around 11,500 BC and spread across Eurasia through the neolithisation process (Zeder 2008, Vigne et al. 2011, Zeder 2011) drove to keep wolves at distance from human settlements (Clutton-Brock 1995, Sablin and Khlopachev 2002, Verginelli et al. 2005).

From this period on, wolves became a potential threat for livestock. They appear as one of the most conflictual species wherever they occur and overlap with herding activities. This conflict has probably been responsible for motivating the past reduction in the number and distribution of large carnivores worldwide (Mech 1995, Breitenmoser 1998, Kaczensky 1999). Nowadays, in many countries, land abandonment, drastic changes in rural land use, and conservation legislation, are leading to the recovery of large carnivores in multiple-use landscapes (Linnell et al. 2001, Falcucci et al. 2007, Chapron et al. 2014) and accordingly many conflicts are currently appearing or increasing in several countries (Skogen et al. 2008, Dressel et al. 2015, Garde 2015, Mech 2017).

Some authors, considering large carnivore economic impacts at the national level and risks to human safety being low, have been proposing that conflicts with large carnivores reflect the long-term persistence of misconceptions and negative perceptions from earlier times (Clark et al. 1996, Kellert et al. 1996, Fritts et al. 2003). On the one hand, however, economic impacts vary according to the considered scale (Kaczensky 1999) and cannot be reduced to killed or injured livestock. Wolf attacks do also influence livestock productivity, impair the breeder's selection process as well as the herd production and structure. In addition, wolf attacks also imply additional working load, induced stress and psychological trauma for livestock breeders and shepherds. On the other hand, several studies have shown that risks to human safety used to exist in Europe and still exist in some developing countries (Rajpurohit 1999, Comincini et al. 2002, Linnell et al. 2003, Löe and Røskaft 2004, Moriceau 2007). Some recent cases, even if rare, also implied wolves coming close to people and even mauling or killing people in North America (McNay 2002, Grooms 2007, Butler et al. 2011, Mech 2017). Therefore, it appears actual conflicts probably find their root in negative aspects of human-wolf relationships rather than in misconceptions. It has also been suggested that prolonged sympatry can lead to a form of coexistence where compromises are made by both species and conflicts are not perceived as being so intense (Mech and Boitani 2003). Such dynamic and interactive vision is supported by the ability of wolves to adapt their behaviour to the environment (Packard 2003, Peterson and Ciucci 2003), including human activities and infrastructure (Ciucci et al. 1997, Theuerkauf et al. 2003).

The impact wolves can have on humans has been addressed through studies about wolves in history, mythology and narratives (see e.g. Lopez 1978, Bobbé 1998, Coleman 2004, Walker 2005), as well as sociological analysis of wolf impacts on human society (Mauz 2005, Skogen et al. 2008, Doré 2010). In most social science studies, animals were generally considered as passive objects. Their ability to influence or be influenced by human practices was rarely taken into account (Brunois 2005). Yet, the existence of animal agency was already suggested in the 1950's when J. Von Uexküll assessed animals have their own world or *Umwelt* (1956). Progress

in ethology, behavioural ecology and cognition drove to reconsider existence of animal personalities (Dall and Griffith 2014) as well as animal ability to adapt their behaviour, facing fast changing human-modified environments (Griffin et al. 2017). Canine cognition has been object of numerous studies asserting their abilities in problem-solving (Miklósi and Kubinyi 2016). Following anthropological perspectives in the relationship between nature and society (Descola and Pálsson 1996, Ellen and Katsuyoshi 1996) and in sociology of science (Latour 1993), animals have been increasingly recognized as actors and active agents able to influence human social life (Ingold 2000, Brunois 2005, Lestel et al. 2005, Descola 2013). This recognition has permitted the development of new interdisciplinary approaches to human-large carnivore relationships spanning both scientific and local knowledge, thus revealing the influence large carnivore behaviour can have on human perceptions and providing insights into the interactive and dynamic character of human-wolf relationships (Lescureux 2006, Lescureux and Linnell 2010, 2013).

If human-wolf relationships are dynamic and may be modified by alterations in either part of the relationship, then social, economic and political transitions in human society should result in changes to the human-wolf relationship. The rapid social changes like the ones which have occurred in most eastern European and central Asian countries at the beginning of the 1990s provided an opportunity to assess the dynamic and interactive nature of human-wolf relationships. Indeed, social changes can have a direct impact on wolf ecology and behaviour through the modification in hunting and livestock husbandry practices, for economic or regulatory reasons. Rapid social changes also create a new ecological and socio-economical context in which the human perception of wolves and their place will be affected, all the more as ecology and behaviour of wolves are adapting to these transformations. In turn, the changes in human perceptions of wolves will influence wolf hunting and livestock husbandry practices. Similarly, the return of the wolves in countries from which they have been away for decades should influence their behaviour since they are confronted with different ecological, social and legal contexts. In addition, the return of the wolves will provoke changes in several human practices, notably husbandry and hunting practices, which will in turn influence wolf behaviour.

The comparison between three different countries which underwent either rapid social changes through different processes (Kyrgyzstan and Republic of Macedonia), or had to deal with the return of the wolves after decades of absence (France) allows us to explore how different contexts have influenced the way human-wolf relationships changed along with these different ecological and social dynamics. Thanks to a combination of historical, geographic, ethnographic data as well as data on wolf damages, our analysis shows that changing social and ecological contexts influence wolf behaviour and human-wolf relationships in a dynamic way. Indeed, if the behaviour of one of the agents – human or wolf – is modified, then this modification will directly alter the behaviour of the other agent and this alteration will soon influence back the first agent. Therefore, it appears that wolves have to be considered as active agents able to adapt their behaviours to human practices. We then propose to take into account wolf ability to adapt when defining and implementing wolf management strategies and conflict management strategies. If wolves are adapting their behaviour to human practices, then it is probably possible to develop practices aiming at changing wolf behaviour. Quite often, conflict management strategies have been focused only on protecting livestock from wolves based on the assumption that human and livestock

guarding dog (LGD) presence are sufficient to deter wolf attacks. They have not been directed towards wolves in order to influence their behaviour towards livestock, dogs, and humans, notably associating them with real danger.

From respected enemies to unwanted pests: Wolves in Kyrgyzstan[1]

At the time of the Russian revolution, Kyrgyzstan was mainly occupied by nomadic livestock breeders and Russian colonists. After the restitution of colonists' land to the Kyrgyz people in 1921-1922, a process of collectivisation and the creation of kolkhozes was initiated from 1925 to 1932, which was accompanied by the settlement of the nomads (Jacquesson 2004). The systems of kolkhozes persisted until the collapse of USSR. Our investigations highlighted that the institutional and economic crisis following this collapse had a strong impact on livestock breeding and hunting activities, which were mainly dependent on the state (Lescureux 2006).

A reorganisation of livestock breeding and hunting activities

Sheep breeding was the agricultural activity most affected by this crisis. Before the transition, all of the land was state property and most of the sheep (77%) were owned by the state and collective farms (Van Veen 1995). At the beginning of the transition process, many flocks were sold or sent to slaughter houses (Jacquesson 2004) and between 1992 and 2004, the number of sheep was reduced to one-third in Kyrgyzstan as compared to that number before the transition, followed by a slight increase after that year (FAO 2012). Private farms gradually replaced collective and state farms (Giovarelli 1998). Intensive livestock farming has been abandoned and changes in the distribution of livestock also occurred. Previously, part of the livestock remained for months in high pastures above 3000m, called *sïrt*, kept by salaried shepherds, cut off from villages and sometimes supplied by helicopter. Now, villagers' livestock tend to graze around the villages because of transhumance costs and the pastures furthest away from the villages are less densely occupied than before (Jacquesson 2004).

The impact of post-soviet upheaval on hunting was quite strong. During the Soviet era, wolf hunting was highly organized at the state level and subsidised. Wolves were considered as pest animals and trapped, captured in dens, poisoned and hunted from planes or helicopters in open areas (Bibikov et al. 1983). The economic and logistical means supporting this intensive wolf hunting were no longer available after the collapse of the USSR. In Kyrgyzstan, each kolkhoz used to have its professional hunters, and shepherds were also equipped with rifles. Hunting was partly an economic activity providing meat, fat, and fur. As a consequence, it is highly probable that the hunting pressure on wolves decreased after the independence of Kyrgyzstan, as in other former Soviet countries (e.g. Belarus, cf. Sidorovich et al. 2003). In addition, members of hunting associations dramatically decreased in Kyrgyzstan from 25900 in 1990 to 8617 in 2002 as a consequence of Russian emigration. Despite the existence of knowledgeable wolf hunters in the villages and wolf bounty, local people have neither the means nor the time to hunt wolves on a regular basis.

Perceived changes in behaviour of the wolves

During our ethnographic fieldwork in Kyrgyzstan, many informants reported that the wolves have changed their behaviour since the fall of the USSR (Lescureux 2007). Not only wolves had become more numerous, but they were also bolder and approached the villages. This drawing closer of the predator was explained in two ways. Firstly, the partial abandonment of high pastures and the regrouping of domestic animals around the villages in winter could drive

wolves to approach the villages in order to find their prey. Secondly, hunting pressure on wolves had decreased. Without rifles, shepherds were no longer able to frighten them. Indeed, the overall presence of armed shepherds in the landscape was perceived as ensuring that wolves had to withdraw back into areas with less human activities instead of coming down to villages. As a consequence, villagers were hardly surprised that wolves were less fearful and no longer hesitated to approach villages and even to attack flocks in broad daylight (Lescureux 2006).

Wolves as one of the main threats to the capital of Kyrgyz villagers

In Kyrgyz villagers' view of the world, there were no strong borders between the human world and the animal world, and wolves were considered as intelligent, conscious and even useful animals, removing carrion and killing sick ungulates. Kyrgyz villagers had a well-shaped view on the fact wolves should not be eradicated since predators belonged to nature and were regarded as having a sanitary role. The wolf was thus perceived as an *alter ego* engaged in reciprocal relationships with humans (Lescureux 2006, 2007). However, Kyrgyzstan had to face a hard and dramatic transition process. Many people complained about the economic situation and all the advantages they lost with the collapse of the Soviet Union (cf. Anderson and Pomfret 2000). With the loss of social security and very low pensions and salaries, livestock became a vital form of capital and most villagers had a few sheep, one or two cows and, sometimes, a few horses. Sheep were mainly kept as a form of capital, which could be sold in case of inflexible expenses (school and university fees, hospitalization, etc.). Under these conditions, villagers were always trying to increase the size of their flock. As a consequence, when wolves attacked livestock, they were threatening villagers' capital, who had the feeling they could not effectively control wolves anymore. The actual lack of control over wolves was viewed as a loss of reciprocity and a break-down in the balance of the human-wolf relationship.

Changes in human practices in the context of the Kyrgyz transition to the market economy have had a clear impact on human-wolf relationships. It has made livestock breeders more vulnerable to wolf attacks and more prone to be highly affected by these attacks since each domestic animal was more valuable than before. The view on the ecological and sanitary role of the wolf was now contested and could be even more contested if this unbalanced relationship persisted. For many villagers, wolves were no longer perceived as a respectable "enemy" they had to regulate, but as an "invader", preventing the increase of a herder's capital, and even threatening the future of pastoralism and economy in the country:

> "*Outside, yaks are eaten by wolves. So we have to keep them in enclosures, like sheep, like horses. So you see neither horses, nor yaks, nor cows outside. So if we don't eliminate the wolves, what do we do with them? The state could give means. If not, where are we going?*" (Shepherd from Korgondu-Bulak, 12/2005)

Wolves as an additional threat to a highly weakened activity in the Republic of Macedonia[2]

The collapse of Yugoslavia had a strong impact on livestock breeding and hunting activities. However, the socio-economic context was quite different from Kyrgyzstan. Indeed, in Yugoslavia, an economic and cultural policy of centralization as well as an accelerated industrialization starting in the 1960's led to an exodus from the countryside to towns and a

concomitant decrease in the agricultural sector (Hadživuković 1989). Shepherds also went to work in other countries, like in Italy, where their knowledge was appreciated (Pardini and Nori 2011). The rural population growth rate started to be negative as early as the 1960s in Yugoslavia. The proportion of the population living in rural areas in Macedonia dropped from 76.6% in 1950 to 27.7% in 2010 (FAO 2012) and Macedonia became mainly urban as early as the 1970s. As a consequence, there has been a strong rural abandonment and a continuous decrease of the rural population (FAO 2012).

A collapse of sheep breeding and a disorganisation of hunting

Sheep breeding in the Republic of Macedonia was quite different from the Kyrgyz one. Even before transition, 90% of the sheep were privately owned even if state or collective farms (*Agro-Kombinat*) had large flocks ranging between 1000 and 25000 sheep (MAFWE 2003). Sheep breeding was highly affected by the transition process. The number of sheep was halved between 1992 and 2006, notably because of a EU ban on the import of lamb meat from the country following the outbreak of foot-and-mouth disease in 1996 (Dimitrievski and Ericson 2010). Moreover, between 1995 and 2007, the domestic consumption of lamb and mutton meat decreased from 10.1kg to 3.3kg per household per year and the domestic consumption of ewe milk and cheese decreased from 15,643 to 11,291 tons per year. According to livestock breeders, the market for lamb meat was not stable and exposed them to economic risks when they did not manage to sell their lamb in time. Subsequently, the low prices of meat, milk, and wool combined with the high prices of fodder and concentrate feed, as well as the rising of labour cost pushed the sheep breeders to reduce their flock size (Dimitrievski and Ericson 2010). Despite the fact that livestock breeding still remains a relatively important economic activity in the country, accounting for 24% of the total agricultural output in the period 1995-2007 (Dimitrievski and Ericson, 2010), livestock breeders are not numerous. Compared to Kyrgyzstan, livestock breeding and especially sheep breeding appears to be a more commercial (rather than subsistence) activity in northwestern Macedonia, focused on cheese and lamb production in a highly seasonal manner.

The impact of the transition process on the organization of hunting was probably less dramatic in former Yugoslavia than in Kyrgyzstan. Macedonia is divided into 249 hunting grounds and apart from the state hunting grounds, an open competition was held in 2002 to award concessions to the highest bidders (Petkovski et al. 2003). According to Petkovski (2003), hunters were largely unsatisfied since they had to pay for expensive management plans when, at the same time, the legal system did not ensure the punishment of poachers. Therefore, many users were not paying their membership fees and poaching was considerably higher than before independence (Republic of Macedonia became independent from Yugoslavia in 1991) as a result of the lack of an organised game warden service. A report from the Ministry of Environment and Physical Planning (2003) also bemoaned the fact that, despite the existence of hunting management plans and a Public enterprise for game wardens and hunting inspections, poaching remained at a high level. Concerning the wolf, the number of wolves reported as being killed has slowly increased since the 1960s and although there are no statistics for the transition period between 1988-1992, it jumped from 200 wolves killed in 1987 to 460 in 1994 (Melovski and Godes 2002), showing that hunting pressure on wolves did not decrease at that time period. Current harvests (2008-2010) have been between 108 and 188 wolves killed per year (Kaczensky et al. 2012).

Wolves as harmful and uncontrollable animals

Macedonian hunters and livestock breeders did not notice any major changes in wolf behaviour after the collapse of Yugoslavia (Lescureux and Linnell 2013). However, in a difficult context for Macedonian livestock breeders, wolves were perceived as harmful animals. The way wolves were perceived was strongly influenced by their behaviour and the various encounters between humans and wolves. Notably, interactions with wolves seem to be particularly linked to livestock. Thus, even if wolves were hidden in the deep forest during the day, they often approached humans when attacking sheep in night-time enclosures on summer pastures. They could even come into the villages, notably to attack dogs in winter, boldly crossing physical and symbolic borders that other predators never crossed (cf. Lescureux and Linnell 2010). The fact that wolves often killed several sheep per attack strengthened the negative perception and many interviewees considered that they enjoyed killing. The reputation of the wolf for excessive killing was widespread and gave rise to some idioms like “the wolf will kill 99 sheep and die at the hundredth” (Elsie 2001, Lescureux and Linnell 2010). When the encounter was not linked to livestock, like when hunters encountered wolves, it was often because the later were attacking dogs and thus initiating the interaction. Not only were such hunting dogs highly valuable for hunters but hunters also noticed the determination of the wolves when attacking dogs. The perceived voracity of wolves did not seem to be limited to domestic animals. Interviewees also blamed them for damage to populations of game animals. Contrary to the bears, to which they were often compared by informants, they were perceived as a rather homogenous population and their harmful characteristics were attributed to the entire species. Because of their perceived damage to wild and domestic animals, and harmfulness to nature in general, wolves were described as “unprofitable monsters” (Lescureux and Linnell 2010).

Not only were the wolves perceived as harmful animals for both livestock and game animals, but they were also perceived as animals very difficult to control. Even if hunting wolves was authorized and encouraged by the state, it was their behaviour and ecology which made them difficult to hunt. Indeed, even though the informants regarded wolves as being territorial in nature, they also reported that they were always on the move, following their prey or looking for livestock, moving to pastures during the summer and to the vicinity of villages in winter. Hard to localize, wolves were not possible to individualise due to their group living, and they also beneficiated from a high reproductive rate. Permanent shepherding and LGDs seem to be widely used in Macedonia (Keçi et al. 2008) and relatively efficient against wolves. However, these mitigation measures were experienced as economic and time constraints by livestock breeders, and they did not function effectively in all cases such as in cases of fog or when wolves managed to slip past LGDs.

As a consequence, human relationships with wolves appeared to be rather unbalanced. On the one hand, these animals often came to take several sheep at a time and their damage could be relatively important at farm or regional levels. In addition, the repeated and fatal intrusions of wolves into domestic space created the impression of an animal that was disrespectful of borders and norms. On the other hand, it was difficult for humans to insure any reciprocity with wolves. The difficulties inherent to wolf hunting in steep, forested habitats hindered the effective implementation of the hunting right.

Redefining the place of the wolf in a changing socio-economic and environmental context

In Macedonia, sheep were not the main capital for most villagers, but rather the resource and occupation of a few professional livestock breeders and their employees. Looking at the results of our investigations, it appears that livestock breeders were mainly complaining about the difficulties inherent to economic activities linked with the transition process and its impact on livestock breeding. Their first complaint was often about the lack of access to markets. There was a widespread view among livestock breeders that it was better before the collapse of Yugoslavia, when the state bought cheese, meat, and wool, paid people to work on pastures and even provided fertilizers. Extensive herding of sheep had become a marginal activity in the country. Livestock breeders had the feeling they were marginalized and that they were not given proper attention by the state, the politicians, or public opinion in general. As a consequence, there was a complete lack of confidence in the future. Many livestock breeders had the feeling that their activity was coming to an end, and that only the biggest and richest livestock owners having access to subsidies and to the market would survive. As a striking consequence of this downward economic situation, most breeders could not invest in or develop their activity, as this man put it:

> "*But if we would have more sheep, we would have more expenses! In this situation, it would be worse*" (breeder from Dobri Dol, 10/2007).

The transition process was not just affecting livestock breeders economically. The ongoing rural abandonment process and the crisis in livestock breeding were also affecting the landscape around the villages as well as the social structures in the villages and in the countryside. Therefore, the livestock breeders' perceptions of their social and natural environment were clearly impacted and also their concerns for the future of their occupation. All the villages in the study area from the Shara Mountains were surrounded by fields and orchards which were now mostly abandoned. As a consequence, there was a feeling that the outskirts of the villages were becoming wild. Thus, pastures were suffering shrub encroachment; fields were becoming pastures and for villagers, the former system of order (village, orchard, field, pasture, forest) was being disrupted. The situation was very similar to what Höchtl et al. (Höchtl et al. 2005) had observed in the southwestern Alps.

In this context, any further cost was a weight that could not be tolerated, and the wolf was mainly considered as a burden adding to these costs. Such a cost may be direct, when the wolf was attacking the flock and taking some sheep. However the cost may also be indirect, through the obligation to keep LGDs, which was also taken into consideration by livestock breeders. Indeed, even if fed with maize flour or old bread mixed with whey, there was a cost to maintain LGDs (around 1€ per dog per day), especially when livestock breeders often had to keep between 5 or more dogs per flock.

Wolves were perceived as bloodthirsty and pest animals, destroying livestock, preying upon dogs and game animals. In the harsh economic and social context of rural Macedonia, wolves were not perceived as the main threat to rural life, but were regarded as an additional threat, which symbolized rural people loss of control over nature, and therefore had to be eliminated, as wolves were absolutely usefulness for them.

France: The return of a protected carnivore in a pastoral landscape[3]

In Kyrgyzstan and Macedonia, the upheaval in the socio-economic context drove to changes in human-wolf relationships, but the situation in France is quite different (Meuret et al. 2017). Indeed, the main change which occurred in human-wolf relationships was the return of the wolves in the French Southern Alps in the 1990s, after decades of absence. This return was officialised and greeted by the French naturalist's magazine Terre Sauvage (Peillon and Carbonne 1993). Under the Bern Convention and the Habitat's Directive, wolves in France were placed under strict protection. Meanwhile, despite the low number of wolves in the 1990s (less than 15), livestock breeders quickly saw the number of killed livestock increase. Wolves were coming back in territories where livestock breeding, and notably sheep breeding, had developed in the absence of predators and following environmental incentives and production choices at the farm level.

Vulnerable breeding systems

In France, following the reform of the Common Agricultural Policy (CAP) in Europe in 1992, environmental public policies started to rely strongly on pastoral and agro-pastoral systems to deal with landscape dynamics and wildlife habitat management plans (Alphandéry and Billaud 1996). Restoration and conservation of summer pastures have been largely entrusted to livestock breeders through five-year contracts, when the latter have been encouraged by means of economic incentives to graze on encroached lands or woodlands prone to wildfire (Léger et al. 1996). In the Natura 2000 management plan for the Alps, livestock grazing had a central role to conserve the biodiversity of alpine meadows, exactly where the wolf came back. Livestock breeders were then confronted with a paradox. On the one side they were encouraged and even funded to redeploy grazing on encroached lands, scrublands, forest edges and undergrowth. On the other side, they were urged to protect themselves from wolves, for which it was easier to attack flocks in such landscapes.

The situation in the French Mediterranean region and Southern Alps also results from production choices, where free-range livestock breeding systems are particularly exposed and vulnerable to predation (Garde 2015). Firstly, almost half a million hectares are scrublands or encroached woodlands (Garde et al. 2014). These areas provide cheap resources for well-adapted livestock and ensure food security and economic robustness for the breeding system (Hubert et al. 2014). In addition, the low snow-cover allows year-round grazing, contrary to higher or up north places where livestock can graze outside only for 6-8 months. The combination of scrublands or woody pastures with year-round grazing makes these breeding systems particularly prone to wolf attacks, notably when considering important topographic constraints.

Another constraint comes from the breeding system itself and production choices. In south-eastern France, sheep production is dominated by sheepfold lambs production. Only empty or pregnant ewes as well as she-lambs are grazing outside. As their food requirements are limited, shepherds can practice close herding along daily grazing circuits and take them back for the night in an enclosure or sheepfold. However, other breeding systems are producing older lambs ("tardons") where both ewes and their lambs are grazing throughout the summer period. As suckling ewes and lambs requirements are higher, shepherds cannot practice close herding and have to let them spread on pasture for longer time during the day. Night enclosure becomes really constraining in that case. Yet, this breeding system is

widespread in Alpes Maritimes, Var and Alpes de Haute Provence, regions with the most frequent instances of wolf depredation in France.

A never-ending increase in livestock damage

From 1994 to 2004, the number of killed or deadly injured animals officially attributed to wolves gradually grew to reach ca. 3000 per year. Less than 300 livestock protection contracts were signed during this first period, but the number has been quadrupled between 2004 and 2009. Livestock breeders have been able to employ shepherd assistants, to buy LGDs and electric fences for night enclosures. Although the number of animal losses reached 4000 in 2005, it decreased and stabilised around 3000 per year from 2006 to 2009[4]. This trend let people assume that protection means were sufficient enough at least to stabilise the situation, even in the case of well-established wolf packs. However, the next seven years (2009-2016) came to contradict this assumption. Even though the number of protected flocks grew from 796 to 2238, the number of killed or deadly injured animals has tripled, up to 10000 per year, while the estimated number of wolves was only increased by 1.5. How can one explain these numbers? A possible explanation is wolf colonization of new territories. Indeed, from 1993 to 2016, wolves have clearly expanded their distribution (Duchamp et al. 2017). They now occupy the entire French Alps and have progressed towards north-eastern France, south Massif Central and eastern Pyrenees. The mainland French Departments with temporal of permanent wolf presence currently amount to 39 out of a total of 95. The hypothesis is that wolves colonize new territories, where livestock breeders are not prepared to protect their flock, which are somehow naïve prey for wolves. However, the number of animal losses continues to grow even in the Alpes Maritimes department, where wolves had arrived already in the 1990s, and the first seven departments colonized by wolves still cumulate more than 90% of the losses in 2015. In addition, about 90% of killed or deadly injured animals belong to protected flocks. These results strongly question the efficiency of livestock protection measures.

Livestock protection measures showing their limits

For livestock breeders and shepherds, the situation is perceived as a loss of control despite the money spent in various measures accompanying the return of the wolf and livestock protection (more than 20 million € in 2015). Protection measures have been quickly promoted and financed by the French State. Conceived and tested in US, Italy and Sweden (Mech 1995), these measures have been based on three postulates:

First, additional human presence – even if not armed – is sufficient to keep wolves at distance: The shepherd assistant. The shepherd assistant is highly valuable. His work consists in helping the main shepherd in supplementary tasks linked with flock protection. The working load has been evaluated around 200 hours per month in the case of a collective sheep flock in a summer pasture (Silhol et al. 2007) and 100 hours in the case of an individual sheep or goat flock outside a summer pasture (Garde et al. 2007).

Second, an additional obstacle, more attentive and vigilant than humans, deters bold wolves: The livestock guarding dog (LGD). After a century of absence in the central and eastern part of France, LGDs have been introduced urgently in the French Alps and Provence starting from the end of the 1990s. LGDs' efficiency is highly variable according to numerous parameters (landscape, breeding system, number of dogs, dog skills, size of the wolf pack, wolf experience and skills, etc.). In addition, considering that the French Alps

are among the most prominent touristic places in Europe, these conditions require from the dogs to be at the same time highly reactive towards wolves and relatively indifferent towards humans, who can be quite numerous (hikers, bikers, hunters, etc.) in and around summer pastures. Therefore, LGDs are becoming a major concern in multi-use landscapes. The number of complaints of people frightened or injured by LGDs is growing (Vincent 2011), while some livestock breeders have been brought before the court due to such conflicting encounters. Mayors are more and more concerned to deal with what is becoming a problem of public safety. In highly touristic places, some mayors have even forbidden the use of LGDs on their territory.

Third, a flock regrouped and kept in a night enclosure under human and dog supervision is attacked no more: The night pen. With large night pens with double enclosure close to LGDs and attentive humans, night penning can be efficient, if feasible in the first place. However, it does not come without heavy constraints. In hilly or mountainous areas, regular night penning is not compatible with sustainable grazing resources management (Savini et al. 2014), prevention of soil erosion (Vincent 2011), and sheep health. Flock moves back and forth the night pen can decrease grazing time 15 to 25%, notably during the summer heat. In addition, night penning is actually put into question as it apparently drove wolves to concentrate their attacks within the day.

Wolves adapting to human practices and presence

Considering the continuous and dramatic increase in killed livestock despite the large scale adoption of protection measures, and also considering that these measures have proven to be relatively efficient for a few years (2006-2009), we wonder whether wolves have learnt to deal with these measures or not, and adapt their behaviour accordingly. Several elements tend to support the ability of wolves to adapt their behaviour to damage prevention methods. One striking fact is that wolves are actually transferring their attacks on sheep flocks during the daytime, after having faced the difficulty to attack them in night pens. In 2010, only 29% of livestock were killed during daytime, whereas in 2015, this proportion has reached over 50%[5]. In addition, wolf attacks are increasing in plains and valleys and some wolves do not hesitate to attack flocks very close to human settlements.

Apart from their damages on livestock, a recent survey in a village from Alpes de Hautes Provence has investigated a case study focusing on a pack of wolves that showed aggressive behaviour towards a teenager (Garde and Meuret 2017). During this survey, numerous testimonies from livestock breeders or shepherds reported encounters with wolves showing no fear of humans, and it appeared that several people had already met this pack at distance but on the same place several times. In other words, under a strict protection status, it seems that wolves tend to adapt their behaviour to different protection means. Even under a strict protection status as in the Italian case, a high level of poaching (Galaverni et al. 2016, Hindrikson et al. 2016) might act as if wolves were hunted. Once wolves have crossed the border to France, the human pressure has strongly decreased on them. However, one of the core constituents of livestock protection measures has always been that human presence would deter wolf attacks on livestock. The crucial question, then, is how long can wolves maintain their fear of humans under a strict protection status?

Conclusions and management implications

Through these different examples we showed that human-wolf relationships are 1) highly dependent on multiple contexts (e.g., socio-economic, cultural, political, ecological) and 2) dynamic and prone to change in case of shifting contexts. In order to understand human-wolf relationships, it is therefore necessary to grasp the broader context as well as its dynamic. In the three countries, the observed developments have influenced human-wolf relationships in two ways (Table 1). In Kyrgyzstan and Macedonia, the transition process has generated multiple socio-economic and environmental trends, by which the place of the wolf has been modified when compared to the previous periods under the USSR or the Yugoslavia regimes. Such changes seem to have been beyond the scope and reach of most wolf management strategies attempted so far, including communication or awareness and outreach campaigns. Indeed, we do not believe in communication campaigns as an effective means to resolve human-wolf conflicts. Based on our experience, these conflicts cannot be explained by so-called lack of knowledge or persistence of misconceptions about wolves among local people. Therefore, trying to act on knowledge and perceptions without changing the terms of human-wolf relationships appears to be ineffective. Instead, it often seems to be instrumental to directly address the human-wolf relationship itself. As Forbes (2009: 234) put it:

> "[R]*elationships are as fundamental as places and things. Conservationists made a strategic error in assuming that our work is more a legal act than a cultural act, in assuming that we can protect land from people through laws, as opposed to with people through relationships*".

The transition processes in Kyrgyzstan clearly affected both livestock breeding and hunting practices, then they influenced the human-wolf relationship, and consequently, they have altered wolf behaviour, since wolves seem to have adapted to new practices. The situation is quite different in France, where the return of the wolf has been the major change affecting hunting and livestock breeding activities. While several damage prevention methods were employed to protect flocks from wolves, the damages are still increasing and it seems that wolves are adapting one way or another to the different barriers put between them and the livestock. In addition, some wolves are showing bolder behaviour under human presence.

In the context of strict protection of the wolf in France or strong decrease of wolf hunting in Kyrgyzstan, one could address the first postulate, on which protection measures have been based, i.e., that additional human presence would be sufficient to keep wolves at distance. Building on the concept of "landscape of fear" (cf. Laundré et al., 2010), which refers to predation risk and any related anti-predator response, Oriol-Cotterill et al. (2015) have conceptualized a "landscape of coexistence" for humans and large carnivores, maintained by means of human-caused mortality risk for large carnivores, through which the latter would act to avoid encounters with humans, for instance, by spatiotemporal partitioning of their activities. However, the risk of human-caused mortality is close to zero under strict protection (poaching excepted). So do wolves fear human presence in any case? Or do wolves fear humans because there have been centuries of hunting regulations, or even persecution? What can be the influence of long-term strict protection of the species on wolf fear of humans?

In the French Alps, there are numerous people sharing the landscape with wolves. Some are hiking, some are biking, and others are mostly looking for birds or flowers. Most humans are not a threat for wolves and it could well be that humans are less and less perceived as such by

wolves. For the wolf, the reward for attacking a sheep flock is quite high: Easy and fat meat, and no need to spend much time in searching, stalking and chasing prey. Comparatively, the risks are quite low. Of course, from time to time, wolves are detected and pursued by a few big dogs they can generally outrun, but they are neither injured nor killed in most of these encounters.

Considering wolves as active agents would entail recognizing their ability to understand part of the context and the other agents they are confronted with, and their ability to adjust their behaviour to the context and to the agents. Livestock protection means are notably based on the assumption that wolves are afraid of humans but wolf fear of humans may not be an intrinsic or everlasting feature of wolf behavioural patterns. It is rather something that has to be maintained through associating human presence with real risks of human-caused injuries to wolves or human-caused mortality. We believe that the efficiency of most protection means is, indeed, dependent on maintaining wolf fear of humans and that the combination of lethal and non-lethal measures is probably the most efficient solution (Bangs et al. 2006). Therefore, we suggest that wolf control through harassment, chasing and killing, should be part of conflict management strategies and would reinforce the efficiency of livestock protection through maintaining risks associated with approaching human settlements, humans themselves, and livestock.

Some recent studies or reviews have questioned the positive effect of hunting on the decrease of predation on livestock (Wielgus and Peebles 2014, Treves et al. 2016), even though there is rather a lack of correctly designed studies on that topic (Allen et al. 2017) and the effect of predator control will vary according to the wolf population numbers and distribution (Mech 2017). Yet, hunting could disrupt wolf social structures and potentially drive to an increase of predation on livestock (Brainerd et al. 2008). Thus, Wielgus and Peebles (2014) reported a positive correlation between the number of sheep depredated and the number of wolves killed the previous year. However, their analysis has been contested in a replication (Poudyal et al. 2016), according to whom the increase in sheep depredation would be a short-term effect confined within the year when culling takes place, followed by a decrease of expected cattle and sheep depredation in the next year, for each individual wolf removed within the previous year. Other studies have shown the effective decrease of livestock depredation following a full or partial wolf pack removal, notably if done quickly after depredation (Bradley et al. 2015). As Treves et al. (2016) put it, predator control should not be “a shot in the dark” and in order to be effective, it has to be correctly designed, implemented, and evaluated according to the expected goal, i.e., maintaining distance with wolves, regulating the population, applying zoning strategies, etc.

Notably, the context has to be taken seriously into account: The husbandry system, the landscape, and of course the wolf control means and the way they will be implemented. To be efficient, wolf control has to be targeted on individuals or packs known to attack livestock in order to (1) eliminate “problem” wolves or packs and (2) to counter select bolder animals. Such control has to be clearly associated with humans so that humans will be be associated with injury/mortality risk by wolves. The creation of a wolf squad[6] (*brigade loup*) in 2015 by the French Ministry of Environment is going into that direction. This squad can be quickly operational on the field right after an attack on livestock and thus it can specifically target wolves responsible for an attack within hours or days following the attack.

Direct action on wolves responsible for attacks on livestock may somehow appear as an act of *reciprocity*, which has been defined as a condition for coexistence between humans and large carnivores (Lescureux 2006, Lescureux and Linnell 2010). Reciprocity implies that management of conflicts between humans and wolves shall imply not only adaptation of humans to wolf presence through livestock protection means, but also adaptation of wolves to human presence and activities through maintaining pressure on wolves in order to keep a distant relationship, when and where it would be necessary.

Table 1. A synopsis of major socio-economic trends, main drivers of the human-wolf conflict, and core challenges and concerns across the three countries studied

	Kyrgyzstan	*Republic of Macedonia, Shara Mountains*	*France, Southern Alps*
Major socio-economic trends	After the transition period (1992), livestock, and sheep, especially, comprises a vital form of capital for most villagers, which may be used to cover of inflexible expenses (school and university fees, hospitalization, etc.).	Livestock breeders feeling marginalized and not given proper attention by the state, the politicians, or public opinion in general; lack of confidence in the future and lack of investment in one's own activity.	Livestock grazing was promoted (1992…) as a central tool for conserving the biodiversity of mountainous and Mediterranean pastures (encroached lands or woodlands prone to wildfire), breeders being encouraged by means of economic incentives through five-year contracts;
Main drivers of the human-wolf conflict	The partial abandonment of high pastures and the regrouping of domestic animals around the villages in winter could drive wolves to approach the villages.	Wolves often approached humans when attacking sheep in night-time enclosures on summer pastures; they could even come into the villages to attack dogs in winter.	High and increasing level of damages on livestock despite the generalized use of protectives methods; landscape and farming systems making livestock highly vulnerable to wolf depredation.
Core challenges and concerns	• Although former perceptions of the wolf reflected a reciprocal human-wolf relationship and tolerance, lack of control over wolves viewed as a loss of reciprocity and a break-down in the balance of the human-wolf relationship • Wolf depredation endangering capital deposited in the form of livestock; the wolf portrayed as an "invader".	• Although not a main threat, wolves adding to rural problems directly (i.e., through depredation) or indirectly (e.g., through a necessary investment in livestock guarding dogs); symbolizing loss of control over nature. • Wolves perceived as "voracious" and thought to cross physical and symbolic borders that other predators never did.	• Damage prevention methods questioned: Night enclosure highly constraining or even non-feasible for breeders using several fenced pastures at a time; livestock guarding dogs conflicts with other land uses, e.g., tourism; Human presence not preventing wolves' attacks, even at daytime and close to villages. • Considerable indications that wolves rapidly adapting to human practices and presence.

References

Allen, B. L., L. R. Allen, H. Andrén, G. Ballard, L. Boitani, R. M. Engeman, P. J. S. Fleming, A. T. Ford, P. M. Haswell, R. Kowalczyk, J. D. C. Linnell, L. David Mech, and D. M. Parker. 2017. Can we save large carnivores without losing large carnivore science? Food Webs **12**:64-75.

Alphandéry, P., and J.-P. Billaud. 1996. L'agriculture à l'article de l'environnement. Études rurales **141**:9-20.

Anderson, K., and R. Pomfret. 2000. Living Standards during Transition to a Market Economy: The Kyrgyz Republic in 1993 and 1996. Journal of Comparative Economics **28**:502-523.

Bangs, E. E., M. D. Jimenez, C. C. Niemeyer, and J. A. Fontaine. 2006. Non-lethal and lethal tools to manage wolf-livestock conflict in the Northwestern United States. Pages 7-16 *in* R. M. Timm and M. O'Brien, editors. Proc. 22nd Vertebr. Pest Conf. University of California, Davis.

Bibikov, D. I., N. G. Ovsyannikov, and A. N. Filimonov. 1983. The status and management of the wolf population in the USSR. Acta Zoologica Fennica **174**:269-271.

Bobbé, S. 1998. Du folklore à la science. Analyse anthropologique des figures de l'ours et du loup dans l'imaginaire occidental. Ruralia **1998**.

Bradley, E. H., H. S. Robinson, E. E. Bangs, K. Kunkel, M. D. Jimenez, J. A. Gude, and T. Grimm. 2015. Effects of wolf removal on livestock depredation recurrence and wolf recovery in Montana, Idaho, and Wyoming. The Journal of Wildlife Management **79**:1337-1346.

Brainerd, S. M., H. Andrén, E. E. Bangs, E. H. Bradley, J. A. Fontaine, W. Hall, Y. Iliopoulos, M. D. Jimenez, E. A. Jozwiak, O. Liberg, C. M. Mack, T. J. Meier, C. C. Niemeyer, H. C. Pedersen, H. Sand, R. N. Schultz, D. W. Smith, P. Wabakken, and A. P. Wydeven. 2008. The Effects of Breeder Loss on Wolves. Journal of Wildlife Management **72**:89-98.

Breitenmoser, U. 1998. Large predators in the Alps: the fall and rise of man's competitors. Biological Conservation **83**:279-289.

Brunois, F. 2005. Pour une approche interactive des savoirs locaux : l'ethno-éthologie. Journal de la Société des Océanistes **120-121**:31-40.

Butler, L., B. Dale, K. Beckmen, and S. Farley. 2011. Findings Related to the March 2010 Fatal Wolf Attack near Chignik Lake, Alaska. ADF&G, Division of Wildlife Conservation, Palmer, Alaska.

Chapron, G., P. Kaczensky, J. D. C. Linnell, M. von Arx, D. Huber, H. Andrén, J. V. López-Bao, M. Adamec, F. Álvares, O. Anders, L. Balčiauskas, V. Balys, P. Bedő, F. Bego, J. C. Blanco, U. Breitenmoser, H. Brøseth, L. Bufka, R. Bunikyte, P. Ciucci, A. Dutsov, T. Engleder, C. Fuxjäger, C. Groff, K. Holmala, B. Hoxha, Y. Iliopoulos, O. Ionescu, J. Jeremić, K. Jerina, G. Kluth, F. Knauer, I. Kojola, I. Kos, M. Krofel, J. Kubala, S. Kunovac, J. Kusak, M. Kutal, O. Liberg, A. Majić, P. Männil, R. Manz, E. Marboutin, F. Marucco, D. Melovski, K. Mersini, Y. Mertzanis, R. W. Mysłajek, S. Nowak, J. Odden, J. Ozolins, G. Palomero, M. Paunović, J. Persson, H. Potočnik, P.-Y. Quenette, G. Rauer, I. Reinhardt, R. Rigg, A. Ryser, V. Salvatori, T. Skrbinšek, A. Stojanov, J. E. Swenson, L. Szemethy, A. Trajçe, E. Tsingarska-Sedefcheva, M. Váňa, R. Veeroja, P. Wabakken, M. Wölfl, S. Wölfl, F. Zimmermann, D. Zlatanova, and L. Boitani. 2014. Recovery of large carnivores in Europe's modern human-dominated landscapes. Science **346**:1517-1519.

Ciucci, P., L. Boitani, F. Francisci, and G. Andreoli. 1997. Home range, activity and movements of a wolf pack in Central Italy. Journal of Zoology, London **243**:803-819.

Clark, T. W., A. P. Curlee, and R. P. Reading. 1996. Crafting effective solution to the large carnivore conservation problem. Conservation Biology **10**:940-948.

Clutton-Brock, J. 1995. Origins of the dog: domestication and early history. Pages 7-20 *in* J. Serpell, editor. The domestic dog: its evolution, behaviour and interactions with people. University Press, Cambridge.

Coleman, J. T. 2004. Vicious: wolves and men in America. Yale University Press, New Haven.

Comincini, M., A. Oriani, C. Morbioli, R. Castiglioni, and A. Martinoli. 2002. L'uomo e la "bestia antropofaga". Storia del lupo nell'Italia settentrionale dal XV al XIX secolo. Unicopli, Milan (Italy).

Dall, S., and S. Griffith. 2014. An empiricist guide to animal personality variation in ecology and evolution. Frontiers in Ecology and Evolution **2**.

Descola, P. 2013. Beyond nature and culture. University of Chicago Press, Chicago.

Descola, P., and G. Pálsson. 1996. Nature and Society. Anthropological perspectives. Routledge, London, UK.

Dimitrievski, D., and T. Ericson. 2010. Sector Study - Macedonian Agriculture in the period 1995-2007. University Ss Cyril and Methodius & Swedish University of Agricultural Sciences, Skopje.

Doré, A. 2010. L'histoire dans les méandres des publics : quand les "méchants loups" ressurgissent du passé. Pages 75-89 *in* J.-M. Moriceau and P. Madeline, editors. Repenser le sauvage grâce au retour du loup. Les sciences humaines interpellées. Presses Universitaires de Caen, Caen.

Dressel, S., C. Sandström, and G. Ericsson. 2015. A meta-analysis of studies on attitudes toward bears and wolves across Europe 1976–2012. Conservation Biology **29**:565-574.

Duchamp, C., G. Chapron, O. Gimenez, A. Robert, F. Sarrazin, R. Beudels-Jamar, and Y. Le Maho. 2017. Expertise collective scientifique sur la viabilité et le devenir de la population de loups en France à long terme. ONCFS & MNHN, Paris.

Ellen, R., and F. Katsuyoshi. 1996. Redefining nature : ecology, culture and domestication. Berg, Oxford, UK.

Elsie, R., editor. 2001. A dictionary of Albanian religion, mythology, and folk culture. New York University Press, New York (USA).

Falcucci, A., L. Maiorano, and L. Boitani. 2007. Changes in land-use/land-cover patterns in Italy and their implication for biodiversity conservation. Landscape Ecology **22**:617-631.

FAO. 2012. FAOSTAT. Food and Agriculture Organization of the United Nations, Roma (Italy).

Forbes, P. 2009. Reciprocity: toward a new relationship. Pages 221-234 *in* R. L. Knight and C. White, editors. Conservation for a new generation. Redefining natural ressources management. Island Press, Washington.

Fritts, S. H., R. O. Stephenson, R. D. Hayes, and L. Boitani. 2003. Wolves and Humans. Pages 289-316 *in* L. D. Mech and L. Boitani, editors. Wolves: behavior, ecology, and conservation. The University of Chicago Press, Chicago.

Galaverni, M., R. Caniglia, E. Fabbri, P. Milanesi, and E. Randi. 2016. One, no one, or one hundred thousand: how many wolves are there currently in Italy? Mammal Research **61**:13-24.

Garde, L. 2015. Sheep Farming in France: Facing the Return of the Wolf. Carnivore Damage Prevention News **11**:17-27.

Garde, L., S. Bacha, J.-F. Bataille, A. N. Gouty, and A. Silhol. 2007. Les éleveurs résidents en zone à loups : Perceptions et stratégies. Pages 180-190 *in* L. Garde, editor. Loup - élevage : s'ouvrir à la complexité. Actes du séminaire des 15 et 16 juin 2006. CERPAM, Manosque.

Garde, L., M. Dimanche, and J. Lasseur. 2014. Permanence and changes in pastoral farming in the Southern Alps. Journal of Alpine Research | Revue de géographie alpine [online] **102**:http://rga.revues.org/2416.

Garde, L., and M. Meuret. 2017. Quand les loups franchissent la lisière. Expériences d'éleveurs, chasseurs et autres résidents de Seyne-les-Alpes confrontés aux loups. CERPAM & INRA, Manosque, Montpellier.

Giovarelli, R. 1998. Land reform and farm reorganization in the Kyrgyz Republic. # 96, Rural Development Institute, Washington.

Griffin, A. S., S. Tebbich, and T. Bugnyar. 2017. Animal cognition in a human-dominated world. Animal Cognition **20**:1-6.

Grooms, S. 2007. Ontario experiences cluster of wolf-human encounters. International Wolf **17**:10-13.

Hadživuković, S. 1989. Population Growth and Economic Development: A Case Study of Yugoslavia. Journal of Population Economics **2**:225-234.

Hindrikson, M., J. Remm, M. Pilot, R. Godinho, A. V. Stronen, L. Baltrūnaité, S. D. Czarnomska, J. A. Leonard, E. Randi, C. Nowak, M. Åkesson, J. V. López-Bao, F. Álvares, L. Llaneza, J. Echegaray, C. Vilà, J. Ozolins, D. Rungis, J. Aspi, L. Paule, T. Skrbinšek, and U. Saarma. 2016. Wolf population genetics in Europe: a systematic review, meta-analysis and suggestions for conservation and management. Biological Reviews:n/a-n/a.

Höchtl, F., S. Lehringer, and W. Konold. 2005. "Wilderness": what it means when it becomes reality - a case study from the southwestern Alps. Landscape and Urban Planning **70**:85-95.

Hubert, B., C. Deverre, and M. Meuret. 2014. The rangelands of southern France: two centuries of radical change. Pages 27-43 *in* M. Meuret and F. D. Provenza, editors. The art and science of shepherding. Acres USA, Austin, Texas.

Ingold, T. 2000. From trust to domination. An alternative history of human-animal relations. Pages 61-76 *in* T. Ingold, editor. The perception of environment. Essays on livelihood, dwelling and skill. Routledge, London and New York.

Jacquesson, S. 2004. Au coeur du Tian Chan : histoire et devenir de la transhumance au Kirghizstan. Cahiers d'Asie Centrale **11/12**:203-244.

Kaczensky, P. 1999. Large carnivore predation on livestock in Europe. Ursus **11**:59-72.

Kaczensky, P., G. Chapron, M. von Arx, D. Huber, H. Andrén, and J. D. C. Linnell. 2012. Status, management and distribution of large carnivores - bear, lynx, wolf & wolverine - in Europe. European Commission, Brussels.

Keçi, E., A. Trajçe, K. Mersini, F. Bego, G. Ivanov, D. Melovski, A. Stojanov, U. Breitenmoser, M. von Arx, G. Schwaderer, A. Spangenberg, and J. D. C. Linnell. 2008. Conflicts between lynx, other large carnivores, and humans in Macedonia and Albania. Pages 257-264 *in* Proceedings of the III congress of ecologists of the Republic of Macedonia with international participation (06-09.10.2007), Struga (Macedonia).

Kellert, S. R., M. Black, C. Reid Rush, and A. J. Bath. 1996. Human Culture and Large Carnivore Conservation in North America. Conservation Biology **10**:977-990.

Latour, B. 1993. We have never been modern. Harvard University Press, Cambridge.

Léger, F., M. Meuret, S. Bellon, J.-P. Chabert, and G. Guérin. 1996. Elevage et territoire : quelques enseignements des opérations locales agri-environnementales dans le sud-est de la France. Renc. Rech. Ruminants **3**:13-20.

Lescureux, N. 2006. Towards the necessity of a new interactive approach integrating ethnology, ecology and ethology in the study of the relationship between Kirghiz stockbreeders and wolves. Social Science Information **45**:463-478.

Lescureux, N. 2007. Maintenir la réciprocité pour mieux coexister. Ethnographie du récit kirghiz des relations dynamiques entre les hommes et les loups. PhD Thesis. Muséum National d'Histoire Naturelle, Paris (France).

Lescureux, N., and J. D. C. Linnell. 2010. Knowledge and Perceptions of Macedonian Hunters and Herders: The Influence of Species Specific Ecology of Bears, Wolves, and Lynx. Human Ecology **38**:389-399.

Lescureux, N., and J. D. C. Linnell. 2013. The effect of rapid social changes during post-communist transition on perceptions of the human - wolf relationships in Macedonia and Kyrgyzstan. Pastoralism: Research, Policy and Practice **3**:4.

Lestel, D., F. Brunois, and F. Gaunet. 2005. Etho-ethnology and Ethno-ethology. Social Science Information **45**:155-177.

Linnell, J. D. C., E. J. Solberg, S. M. Brainerd, O. Liberg, H. Sand, P. Wabakken, and I. Kojola. 2003. Is the fear of wolves justified? A Fennoscandian perspective. Acta zoologica Lituanica **13**:34-40.

Linnell, J. D. C., J. E. Swenson, and R. Andersen. 2001. Predators and people: conservation of large carnivores is possible at high human densities if management policy is favourable. Animal Conservation **4**:345-349.

Löe, J., and E. Røskaft. 2004. Large Carnivores and Human Safety: a review. Ambio **33**:283-288.

Lopez, B. H. 1978. Of wolves and men. Charles Scribner's sons, New York.

MAFWE. 2003. Country Report on the State of the Animal Genetic Resources in Republic of Macedonia. Republic of Macedonia Ministry of Agriculture, Forestry and Water Economy, Skopje.

Mauz, I. 2005. Gens, cornes et crocs. Inra-Quae, Paris, Grenoble.

McNay, M. E. 2002. Wolf-Human interactions in Alsaka and Canada: a review of the case history. Wildlife Society Bulletin **30**:831-843.

Mech, L. D. 1995. The challenge and opportunity of recovering wolf populations. Conservation Biology **9**:270-278.

Mech, L. D. 2017. Where can wolves live and how can we live with them? Biological Conservation **210, Part A**:310-317.

Mech, L. D., and L. Boitani. 2003. Wolves: behavior, ecology, and conservation. The University of Chicago Press, Chicago.

Melovski, L., and C. Godes. 2002. Large Carnivores in the "Republic of Macedonia" (recognised by Greece as: "the Former Yugoslav Republic of Macedonia"). Pages 81-93 *in* S. Psaroudas, editor. Protected areas in the Southern Balkans - Legislation, Large Carnivores, Transborder Areas. Arcturos and Hellenistic Ministry of the Environment, Physical Planning, and Public Works, Thessaloniki (Greece).

Meuret, M., L. Garde, C.-H. Moulin, N.-P. Marie-Odile, and M. Vincent. 2017. Élevage et loups en France: historique, bilan et pistes de solution. INRA Productions Animales **30**:465-478.

Miklósi, Á., and E. Kubinyi. 2016. Current Trends in Canine Problem-Solving and Cognition. Current directions in psychological science **25**:300-306.

Ministry of Environment and Physical Planning. 2003. Biodiversity Strategy and Action Plan for the Republic of Macedonia. Skopje.

Moriceau, J.-M. 2007. Histoire du méchant loup. 3 000 attaques sur l'homme en France. Fayard, Paris.

Olsen, S. J. 1985. Origins of the domestic dog: the fossil record. The University of Arizona Press.

Oriol-Cotterill, A., M. Valeix, L. G. Frank, C. Riginos, and D. W. Macdonald. 2015. Landscapes of Coexistence for terrestrial carnivores: the ecological consequences of being downgraded from ultimate to penultimate predator by humans. Oikos **124**:1263-1273.

Packard, J. M. 2003. Wolf behavior: reproductive, social, and intelligent. Pages 35-65 *in* L. D. Mech and L. Boitani, editors. Wolves: Behavior, Ecology and Conservation. The University of Chicago Press, Chicago and London.

Pardini, A., and M. Nori. 2011. Agro-silvo-pastoral systems in Italy: integration and diversification. Pastoralism: Research, Policy and Practice **1**:26.

Peillon, V., and G. Carbonne. 1993. Bienvenue aux loups. Terre Sauvage **73**:23-42.

Peterson, R. O., and P. Ciucci. 2003. The wolf as a carnivore. Pages 104-130 *in* L. D. Mech and L. Boitani, editors. Wolves: behavior, ecology, and conservation. The University of Chicago Press, Chicago.

Petkovski, S., D. Smith, T. Petkovski, and V. Sidorovska. 2003. Study on hunting activities in Macedonia: past, present and future. Society for the Investigation and Conservation of Biodiversity and the Sustainable Development of Natural Ecosystems (BIOECO), Skopje.

Poudyal, N., N. Baral, and S. T. Asah. 2016. Wolf Lethal Control and Livestock Depredations: Counter-Evidence from Respecified Models. PLoS ONE **11**:e0148743.

Rajpurohit, K. S. 1999. Child Lifting: Wolves in Hazaribagh, India. Ambio **28**:162-166.

Sablin, M. V., and G. A. Khlopachev. 2002. The earliest ice age dogs: evidence from Eliseevichi 1. Current Anthropology **43**:795-799.

Savini, I., E. Landais, P. Thinon, and J.-P. Deffontaines. 2014. Taking advantage of an experienced herder's knowledge to design summer range management tools. Pages 89-111 *in* M. Meuret and F. D. Provenza, editors. The art and science of shepherding. Acres USA, Austin, Texas.

Sidorovich, V. E., L. L. Tikhomirova, and B. Jędrzejewska. 2003. Wolf Canis lupus numbers, diet and damage to livestock in relation to hunting and ungulate abundance in northeastern Belarus during 1990-2000. Wildlife Biology **9**:103-111.

Silhol, A., J.-F. Bataille, R. Dureau, L. Garde, and T. Niez. 2007. Evaluation du schéma de protection des troupeaux en alpage : coût, travail, impact. Pages 166-178 *in* L. Garde, editor. Loup - élevage : s'ouvrir à la complexité. Actes du séminaire des 15 et 16 juin 2006. CERPAM, Manosque.

Skogen, K., I. Mauz, and O. Krange. 2008. Cry Wolf!: Narratives of Wolf Recovery in France and Norway. Rural Sociology **73**:105-133.

Theuerkauf, J., W. Jedrzejewski, K. Schmidt, and R. Gula. 2003. Spatiotemporal Segregation of Wolves From Humans in the Bialowieza Forest (Poland). Journal of Wildlife Management **67**:706-716.

Treves, A., M. Krofel, and J. McManus. 2016. Predator control should not be a shot in the dark. Frontiers in Ecology and the Environment **14**:380-388.

Van Veen, T. W. S. 1995. The Kyrgyz sheep herders at a crossroad. Pastoral Development Network Series **38**:1-14.

Verginelli, F., C. Capelli, V. Coia, M. Musiani, M. Falchetti, L. Ottini, R. Palmirotta, A. Tagliacozzo, I. De Grossi Mazzorin, and R. Mariani-Costantini. 2005. Mitochondrial DNA from prehistoric canid highlights relationships between dogs and South-East european wolves. Molecular Biology and Evolution **22**:2541-2551.

Vigne, J.-D., I. Carrère, F. Briois, and J. Guilaine. 2011. The Early Process of Mammal Domestication in the Near East. New Evidence from the Pre-Neolithic and Pre-Pottery Neolithic in Cyprus. Current Anthropology **52**:S255-S271.

Vincent, M. 2011. Les alpages à l'épreuve des loups. Quae & MSH, Montpellier.

Von Uexküll, J. 1956. Mondes animaux et mondes humains. Denoël, Paris.

Walker, B. L. 2005. The lost wolves of Japan. University of Washington Press, Seattle.

Wielgus, R. B., and K. A. Peebles. 2014. Effects of Wolf Mortality on Livestock Depredations. PLoS ONE **9**:e113505.

Zeder, M. A. 2008. Domestication and early agriculture in the Mediterranean Basin: Origins, diffusion, and impact. Proceedings of the National Academy of Science **105**:11597-11604.

Zeder, M. A. 2011. The Origins of Agriculture in the Near East. Current Anthropology **52**:S221-S235.

---

[1]This section is based on results from a 10-month ethnographic survey undertaken between 2003 and 2007 (Lescureux, 2007). Several villages from Naryn and Issyk-Köl regions were investigated through participant observations and semi-directive interviews (n=91) using snowball sampling, and focus was put on local ecological knowledge on animals in general and wolves in particular.

[2]This section is based on the results from seven months of fieldwork in Macedonia, undertaken by the first author between 2007 and 2011, and focusing on local knowledge on bears, wolves and lynxes as well as the use of livestock guarding dogs. The ethnographic survey took place mainly in Shara Mountains in the northwestern part of the Republic of Macedonia. Snowball sampling was used and 63 hunters and livestock breeders were interviewed in 33 villages.

[3]This section is based on regular field and technical work undertaken by L. Garde and M. Meuret as well as analysis of official data on wolf damages on livestock (Direction régionale de l'Environnement de l'Aménagement et du Logement Auvergne Rhône Alpes (DREAL-AURA and GéoLoup database, a database with restricted access directly depending from the French Ministry for Environment).

[4]Data on wolf damages on livestock come from Direction régionale de l'Environnement de l'Aménagement et du Logement Auvergne Rhône Alpes (DREAL-AURA) and from GéoLoup database, a database with restricted access directly depending from the French Ministry for Environment. Raw data from GéoLoup database are accessed by Centre d'Etude et de réalisation Pastorales Alpes Méditerranées (CERPAM). Analysis and comparison (protected vs. non protected; daylight vs. night, etc.) have been undertaken by the authors.

[5]Analysis undertaken by CERPAM and based on the national database of Géoloup. Cf. note 1.

[6]Squad of support to livestock breeders against wolf attacks. Their mission is to participate to livestock protection with defensive shots, to support the agents from the National Office for Hunting and Wildlife management (ONCFS) in their actions to scare or remove wolves, and to participate in documenting and evaluating wolf predation on livestock.