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Carnivore Damage Prevention

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not an easy puzzle

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used in agriculture

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EDITORIAL

Dear Readers,

It is with great pleasure that we can bring you another issue of Carnivore Damage Prevention News. The layout team have done a wonderful job producing yet another beautiful issue where the visuals not only help communicate the stories, but also serve to inspire. The landscapes where large carnivores and livestock interact are beautiful, the traditions of livestock production evident, the fascination of the predators is clear. This newsletter is dedicated to finding a way to integrate these three elements into the same space. The other sign of maturity is in the content of the articles. On the surface, we are serving up seven very different articles that bring the reader on a journey from Australia to Austria, from Russia to Portugal and Spain, with several stops in Switzerland on the way! Yet there is a clear message in this diversity of articles: addressing conflicts between large carnivores and livestock requires multiple approaches and knowledge of multiple issues. One of these requirements is a good scientific understanding of the underlying behaviour of the predators, and two articles provide insights from behavioural studies on captive wolves. They explore how wolves react to electric fences and to changes in their environment. While these types of study can obviously not simulate the full complexity of the field they do provide some insights into the mind of wolves which can help us understand what we see in the field. Further such experiments can continue to add little pieces to the puzzle of getting inside the head of the most adaptable predator that roams the Earth.

However, most rewarding in this set of articles is the focus on the challenges faced by livestock producers as they struggle to adapt to the presence of large carnivores. This producer focus provides a much-needed reality check to well-intentioned interventions as it shows us just how many different elements need to be coincide for a new husbandry system to develop. Certainly, we need to have technical solutions that work: be they livestock guarding dogs, electric fences, night-time enclosures or paddock fences that allow adult cows to pass but not calves. Typically articles in scientific journals focus on these issues. In contrast, the less formal format of the CDPNews allows other perspectives and experiences to gain prominence. The articles in this issue go on to underline how the social and cultural environment can affect the willingness of producers to make changes in the face of their neighbours who may be less cooperative. They also underline how the economic incentives need to be designed to fit the local reality, and just how many other details need to fall into place. Legislation for working dogs, education and accommodation for shepherds, access to advice and training for shepherds to name a few. Success requires all these elements to fall into place together. Failure can be caused by a problem in any one of the elements. Coordination and integration of measures is the key.

It is welcome that several of the articles point out the limits of any given approach, and realistically admit to the massive challenges involved with adapting the extensive free-grazing systems in Iberia and the Alps. However, the examples from Tyrol and the Valais also show how husbandry systems can be transformed using an integrated approach, and if there is a sufficient understanding of the producers' situation and local conditions.

Achieving coexistence between people and predators is not easy. It will never be a state of harmony. But, we think we have grounds to believe that it is possible to reach a situation where there is a workable compromise. If we all pull together and share experiences. And that is what motivates this newsletter.

The Editors

Short Communication

LIVESTOCK GUARDING DOGS: FROM TRADITION TO MODERNITY

RESULTS OF AN INTERNATIONAL MEETING

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The use of livestock guarding dogs (LGDs), an ancient and traditional way of protecting livestock from predators, has gained renewed relevance in recent decades within the scope of large carnivore conservation efforts. As top predators return to parts of their former ranges, new challenges have emerged regarding the use of LGDs which must be dealt with if we want to expand and increase the success of this damage prevention tool.

To discuss these issues, an international meeting of LGD experts was organized in the scope of the LIFE MedWolf Project (Best practice actions for wolf conservation in Mediterranean-type areas) to promote the sharing of experience, contribute to the definition of the current state of knowledge on the use of LGDs and help identify new lines for future research and collaboration.

Participants of the LGD Meeting held in October 2015, in Castelo Branco, Portugal.

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An Estrela Mountain Dog watches over its goat flock in the central mountains of Portugal, protected with a spiked iron collar. Photo: Julie Young.

Organized by Grupo Lobo, the meeting also involved Istituto di Ecologia Applicata (Italy), AGRIDEA (Switzerland), and IPRA (Institute for the Promotion and Research on Guarding Animals, Switzerland). Sixteen managers and researchers, including representatives of the Project partners from Italy and Portugal, from six other European countries (Spain, France, Switzerland, Slovakia, Bulgaria and Croatia), as well as from Australia and the USA, met at Escola Superior Agrária de Castelo Branco (Castelo Branco, Portugal), from the 20th to 21st October 2015.

Prior to the meeting a field trip was organized to two different regions of central Portugal within the wolf range and with distinct husbandry methods where, LGDs are used in different contexts. This was a good opportunity for the participants to learn more about local wolf conservation issues and prevention methods, focusing mainly on LGDs. The four farmers and holdings visited have been involved in the LGD Programme developed by Grupo Lobo, and two have received dogs from the MedWolf Project.

Three work sessions were organized during the meeting aimed at answering the following questions: 1) How can we assess the efficacy of LGDs? 2) How can we improve the efficacy of LGDs? 3) Are there limits to the use of LGDs? Possible solutions to these limitations were also proposed by the participants. Before going into the discussion, some initial concepts concerning the function and selection of LGDs were defined to help set the baseline for the work sessions that followed. A summary of the contributions of the participants to all the topics discussed is presented below.

1. LGDs: What are they for and how to select them

1.1. What is a LGD?

A LGD is a dog that has the function of protecting livestock from threats (e.g. predators, intruders). Their selection has primarily been based on working abilities (form and behaviour) and cultural preferences, and their behaviour allows them to stay with livestock (establish bonds, stay close and follow) and naturally protect it from predators. Several regional types exist that are adapted to local environmental conditions and needs, and other human activities; some of these have been recognized as breeds. Owner perception must also be considered, as well as cultural aspects, since these dogs have (or had) an important place in communities. They have always been a tool for mitigating conflicts with large carnivores, enabling coexistence.

1.2. Why would you need a LGD?

These dogs are part of the traditional husbandry system to reduce damage and mitigate conflicts, but other reasons for owning LGDs may exist, including social and psychological motivations (e.g. providing a sense of security, property guard, companion or social status). Tradition and knowledge are important and facilitate the use of LGDs, but in some regions the use of LGDs as protection against theft may have legal implications which should be considered.

1.3. How would you select a LGD?

Working ability (behaviour and form) is fundamental. Some tests are used to select pups and a stable character is important, but behaviour may change during early development stages, and thus it may be easier to select against undesirable behaviour. More information is needed to help in dog selection, and both dog breeders' and shepherds' contributions should be considered when defining selection criteria.

The first months of a pup's life are fundamental to shape its behaviour, but there is also individual variability to account for, and selection should be based on the quality of a dog's behaviour. It is important to take into

Work sessions during the LGD Meeting, at Escola Superior Agrária de Castelo Branco, Portugal. Photo: Robin Rigg.

consideration that LGDs work as a group and dogs with different temperaments should be used together, since they can complement each other. Different lines exist upon which to select dogs, but inbreeding should be avoided. Ongoing selection takes place during the course of the dogs' lives, with inefficient dogs usually being removed and transferred either to different working conditions or to other functions.

2. LGDs: How to assess, improve and innovate

Three work sessions were organized aimed at answering questions on how to assess and improve the efficacy and efficiency of LGD and perceived limits to their use. The main results of the working groups' discussions are presented below, according to each of the three topics debated.

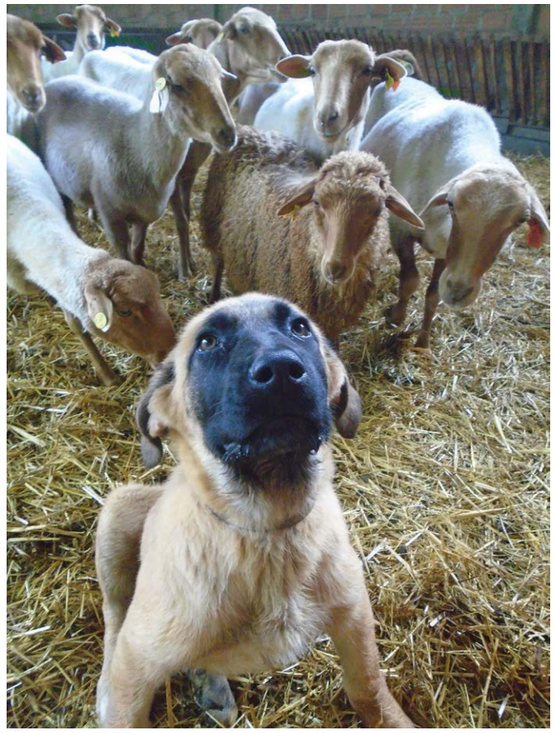
2.1. How can we assess the efficacy and efficiency of LGDs?

Proposals regarding the assessment of the efficacy of LGDs focused on different levels of assessment (individual farm and overall damage reduction, considering also owner perception), and timeframes (immediate and long-term) and on the possible correlations between them. The following criteria were proposed: a measure of the reduction of predation on livestock after LGD integration; a cost-benefit analysis (including time investment, mortality and morbidity of LGDs); owner satisfaction and perception of LGD performance/behaviour; LGD behaviour and predator response; level of engagement of farmers; and adaptability of LGDs to different contexts (human tolerance, husbandry, predators and predatory pressure, number of LGDs, habitat).

2.2. How can we improve the efficacy and efficiency of LGDs?

Proposals to improve the efficacy of LGDs focused on the implementation of best practices in the scope of an adaptive management to potentiate LGD success, as well as continued support to and networking between farmers. Specifically, the following measures were proposed: identifying best practices concerning the use of LGDs (education, maintenance, breeding, selection) and of livestock management/selection to reduce predation risk; adapting husbandry systems to the use of LGDs and complementing their use with other preventive measures; increasing existing knowledge (traditional and new) and providing continued assistance to farmers; matching dog breed and behaviour to local conditions; using a balanced dog team; promoting bonding/training of dogs; preventing risks (accidents, diseases); informing the public (tourists, hunters, neighbours); learning about and adapting laws to the use of LGDs; and promoting exchanges and networks between shepherds (information, experience, dogs).

Karakachan Dog accompanying the flock in the mountain pastures of Bulgaria, where wolves are frequently present. Photo: Sider Sedefchev.



Bonding with the flock during the first months of this Estrela Mountain Dog pup's life is fundamental for later success.

2.3. What are the possible limitations to the use of LGDs?

Several aspects were mentioned that could limit the use of LGDs. Specifically, the following issues were raised: high human densities; restrictions to dog breeds; lack of background about the use of LGDs; personal limitations (lack of motivation, responsibility, or affinity to dogs); legal liabilities; limitations by conservation policies or other legislation; economic constraints; low cost-benefit; lethal predator control; conflicts with other activities (hunting, tourism) and interests (prejudices and intolerance); urgent interventions vs. operational activity; unsuitable husbandry systems (lack of bonding opportunities, high mortality risks); herders' biases; or lack of access to LGDs.

2.4. Are there solutions to perceived limitations?

A diverse range of solutions were proposed to tackle the constraints identified. Those included: participatory approaches to devise solutions that accommodate different activities and community concerns; education and communication actions about the benefits of using LGDs, as well as economic, ethical and welfare issues; improving the selection and training of dogs in order to reduce aggressiveness and wandering and increase bonding and efficiency, or even train/desensitize dogs to avoid specific areas or species; placing experienced adult dogs; creating a network of farmers and dog breeders; disseminating know-how and implementing pilot actions; providing technical support and creating financial incentives; buying insurance to avoid legal liabilities; promoting predator-friendly farming labels; equipping dogs with GPS collars or bells to locate/control them; setting up interest groups to work and lobby for changes in legislation and enhance policies.

Farmers should be aware of predation risk and encouraged to be proactive and optimize dog management to improve cost-benefit. Viability studies should be done beforehand to assess the feasibility of using LGDs, and when necessary to recommend alternative or complementary methods.

Some of these solutions are already being implemented with good results, but additional research should be developed, mainly concerned with dog selection and training. A detailed discussion of these constraints and solutions will be presented in a future article.

A Maremma Sheepdog stands his ground in Australia, protecting a cattle herd from wild dogs. Photo: Linda van Bommel.

3. Share experience

The need to share experience was highlighted and the establishment of an international working group focused on LGDs was proposed. Exchange of experience regarding progress achieved, problems encountered and ways to solve them, as well as the transfer of information about the development of new methods and tools to evaluate LGDs in different scenarios (e.g. research with GPS dog-collars) was considered fundamental. To this end a forum will be created within the AGRIDEA website to share documents and other information among the members of the group and to facilitate discussion.

The sharing of equipment and the establishment of residency programmes for researchers and managers were also suggested. The development of joint research projects was proposed as a way to promote the exchange of knowledge mentioned above and to help cement the working group, and regular meetings should be organized, including visits to holdings using LGDs.

The expectations and needs of the participants regarding this group were discussed and concrete actions were proposed. For example, the production of a pan-European document compiling the main national legislation concerning the use of LGDs, extracting best practice, identifying the main obstacles and proposing possible solutions and recommendations could be very helpful for managers. The definition of a minimum and optimal number of dogs per flock (considering the sex ratio of the dogs in the group) was also considered important, and a joint study should be initiated with data provided from several countries.

4. Future challenges

Research directions and new challenges concerning the use of LGDs were also pointed out. The development of applied research was considered fundamental to increase our knowledge, particularly about the behaviour of both LGDs and predators, and to identify the most adequate criteria and tests to use in dog selection procedures.

A dearth of funding programmes, and the reduced economic power of farmers to buy and maintain LGDs, may hinder the implementation and continuation of LGD programmes in some countries. Nevertheless, some funding options exist within the EU, such as the LIFE Programme and the Rural Development Programme, that contain measures activated in some areas and to which farmers can apply.

The greater challenge is to find viable and socially acceptable solutions in areas of recent large carnivore re-colonization where husbandry practices have drastically changed and are no longer adapted to the presence of predators. To do so we must consider the traditional knowledge associated with the use of LGDs, but embrace technology to successfully adapt the use of LGDs to a modern rural society.

Achieving coexistence with large carnivores depends on developing solutions that provide viable livelihoods for farmers, meet societal needs, expectations and values (e.g. ethics, animal welfare), while contributing to protect ecosystems and enhance biodiversity. Good examples exist and innovative and valuable ideas are continuously arising. With the consolidation of society awareness about the importance of biodiversity conservation and of the drive to coexist, we will surely succeed.

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Short Communication

FREE RANGING LIVESTOCK, WOLVES AND DAMAGE PREVENTION METHODS: NOT AN EASY PUZZLE

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In human-dominated landscapes, multiple ecological, social, cultural and economic factors influence human-wolf relationships (Llaneza et al., 2012). Many governments enforce, support and implement practices to mitigate conflicts between wolves and farmers by adopting compensation systems for livestock losses (Agarwala et al., 2010; Maheshwari et al., 2014), promoting damage prevention methods such as fences or guard dogs (Salvatori and Mertens, 2012; Kaczensky et al., 2013), and permitting lethal control of wolves (Linnell et al., 2005). However, empirical evidence on the efficacy of each of these actions is limited or even contradictory (Agarwala et al., 2010; Wielgus and Peebles, 2014). In order to mitigate conflicts properly we need to understand their causes, which sometimes can be complex (Chapron and López-Bao, 2014). An increase in our knowledge of the factors affecting the conflict in a given area should contribute to mitigate it more effectively.

Free-ranging livestock practices are common in the northwest of the Iberian Peninsula (López-Bao et al., 2013; Álvares and Blanco, 2014). As a consequence of subsidies for cattle production from the EU, numbers of free-ranging (beef) cattle in areas with wolves and cattle losses to wolf predation have shown an increasing trend during the last decades (Álvares and Blanco, 2014). For instance, in Castilla y León, which has more than 50% of the Iberian wolf population, the number

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Fig. 1. The farmer and the wolf. One of the wolves was live-trapped within the collaborating farm and the farmer was invited to attend its release with GPS collar fitted.

of sheep and goats affected by wolf attacks increased by 10% from 1,434 in 2005 to 1,579 in 2012, whereas the number of cattle affected by wolf attacks increased 4-fold from 131 in 2005 to 543 in 2012 (Junta de Castilla y León, 2013).

In Pontevedra province, the main livestock husbandry practice includes extensive cattle grazing. In addition, upland heathlands are occupied by free-ranging horses feeding on low-quality forage and forming small herds that roam unattended and breed freely in communal lands year-round (López-Bao et al., 2013). Therefore, mountains are permanently occupied by hundreds of dispersed cattle and horses with their respective calves and foals, being extremely vulnerable to wolf attacks. Livestock constitutes the main food resource for wolves in the area, where wild ungulates occur at low densities (López-Bao et al., 2013). Although cattle and horses are similar in body size and husbandry practices, wolf predation on cattle and horses has different socio-economic impacts (López-Bao et al., 2013). While cattle constitute an important source of income for families, free-ranging ponies currently have low economic value. In fact, some farmers admit that they raise ponies because they think that wolf predation on foals reduces the impact on calves, which are much more valuable (authors' unpublished data). Compensation for wolf damages is greater for cattle (EUR 218-1,635) than horses (EUR 158-792, depending on age and breed) (Xunta de Galicia, 2011). In this scenario, the protection of cattle, and particularly calves, which are more prone to wolf predation (Álvares, 2011; Dondina et al., 2015), seems a priority for mitigating conflicts.

Shepherds, livestock guarding dogs and fences are the most commonly used methods to prevent wolf attacks (Reinhardt et al., 2012). The efficacy of these methods varies widely among regions, depending on husbandry methods and livestock species (Breitenmoser et al., 2005; Reinhardt et al., 2012; Salvatori and Mertens, 2012). Prevention of damage in extensive grazing systems presents a particular challenge due to the scattered distribution of livestock and the extensive area to protect (hundreds of hectares). In these circumstances, methods such as the use of livestock guarding dogs may be less efficient than, for instance, when protecting sheep herds (Breitenmoser et al., 2005; Rigg et al., 2011). The cost-effectiveness of free-ranging livestock is based on the low investment required. Husbandry practices implying an "extra" investment of time, money or effort, are often rejected by farmers, even if such investment is expected to reduce wolf damages. Therefore, it is of great interest to test methods that could minimize wolf predation without requiring substantial investment.

Extensive livestock farming systems are arguably the least suitable to achieve a low-conflict coexistence with large carnivores. However, unless there are major changes in agricultural and environmental policies (e.g. promoting husbandry practices such as surveillance or protection of calves against wolf predation in order to compensate the loss in competitiveness with respect to the same extensive livestock systems located in areas without wolves), this is likely to remain the dominant system we have to deal with to mitigate conflicts.

A prerequisite to detect and solve problems in a system is to understand how the system works. For this reason, in summer 2013, we began a multidisciplinary pilot project to study the relationships among livestock, wolves, wolf predation, and damage prevention methods in Pontevedra, Galicia. This project, entitled "Asistencia técnica para el seguimiento de manadas, realización de ensayos y evaluación de daños provocados por el lobo en explotaciones ganaderas de Galicia", Ref: TEC0003570, was contracted by Tecnologías y Servicios Agrarios, S.A. (TRAGSATEC) and financed by the Spanish Ministry of Agriculture, Food and the Environment (MAGRAMA). It had two different objectives:

1) To evaluate the impact of wolves on livestock. We equipped five wolves with GPS collars to study wolf predation (Fig. 1). The main aim was to obtain information about wolf predation on livestock in this particular husbandry system. This information will allow us to know the real impact of wolf predation on livestock and to detect problems that could affect the level of conflict (e.g. detectability of prey remains). In addition, we equipped 44 foals with collars to study the causes of foal mortality.

2) To test livestock damage prevention methods for free-ranging cattle in a farm suffering recurrent wolf attacks. We designed and tested a system to protect calves with minimum extra labour for the farmer, based on the installation of an enclosure to keep calves protected with "selective" gates allowing only the dams to pass through (Fig. 2). Using this system, cattle roam freely and nurse their calves in enclosures safe from wolf predation (Fig. 3). In line with the recommendations of the EU Platform on Coexistence between People and Large Carnivores regarding techniques and solutions for mitigating so-called material conflicts, the Spanish Ministry of Agriculture, Food and the Environment recently opened a specific work-line for protected species

Fig. 2. Selective gate. Adult cattle can see over the gate (made of opaque materials) and therefore what is beyond it. They easily learn to push the gate to exit freely. In contrast, small calves cannot see what is beyond the gate and so do not dare to push it, remaining inside the enclosure.

Fig. 3. Calves remain safe from wolf attacks inside the enclosure while their mothers graze.

focused on prevention measures, including this type of enclosure as a recommendation for reducing wolf damage. We aimed to evaluate the efficacy of this system to prevent wolf predation on calves and to quantify the investment needed to implement this method, i.e. the extra investment needed for cows to learn to use the selective gates without the help of the farmer.

For detailed information on this type of enclosure visit the official web site of the Ministry at: http://www.magrama.gob.es/es/biodiversidad/temas/conservacion-de-especies/ce_silvestres_resolucion_lobo_bovino_tcm7-358441.pdf

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References

Agarwala M, Kumar S, Treves A, Naughton-Treves L (2010) Paying for wolves in Solapur, India and Wisconsin, USA: Comparing compensation rules and practice to understand the goals and politics of wolf conservation. Biological Conservation 143, 2945–2955.

Álvares F, Blanco JC (2014) Recovering traditional husbandry practices to reduce wolf predation on free-ranging cattle in Iberia. Carnivore Damage Prevention News 10, 4–9.

Álvares F (2011) Ecologia e conservaçao do lobo (Canis lupus, L.) no Noroeste de Portugal. PhD Thesis, Universidade de Lisboa, Portugal.

Breitenmoser U, Angst C, Landry J-M, et al. (2005) Non-lethal techniques for reducing depredation. In: Woodroffe R, Thirgood S, Rabinowitz A, editors. People and wildlife: conflict or co-existence? Cambridge University Press, Cambridge, pp. 49-71.

Chapron G, López-Bao JV (2014) Conserving carnivores: politics in play. Science 343, 1199–1200.

Dondina O, Meriggi A, Dagradi V, et al. (2015) Wolf predation on livestock in an area of northern Italy and prediction of damage risk. Ethology Ecology & Evolution 27, 200-219.

Junta de Castilla y León (2013) Análisis justificativo para la revisión del Plan de Conservación y Gestión del lobo en Castilla y León. Junta de Castilla y Léon, 73 p.

Kaczensky P, Chapron G, von Arx M, et al. (2013) Status, management and distribution of large carnivores – bear, lynx, wolf & wolverine – in Europe, Part 2. European Commission, 200 p.

Linnell JC, Nilsen EB, Lande US, et al. (2005) Zoning as a means of mitigating conflicts with large carnivores : principles and reality. In: Woodroffe R, Thirgood S, Rabinowitz A, editors. People and wildlife: conflict or co-existence? Cambridge University Press, Cambridge, pp. 162-175.

Llaneza L, López-Bao JV, Sazatornil V (2012) Insights into wolf presence in human-dominated landscapes: the relative role of food availability, humans and landscape attributes. Diversity and Distributions 18, 459-469.

López-Bao JV, Sazatornil V, Llaneza L, Rodríguez A (2013) Indirect effects on heathland conservation and wolf persistence of contradictory policies that threaten traditional free-ranging horse husbandry. Conservation Letters 6, 448-455.

Maheshwari A, Midha N, Cherukupalli A (2014) Participatory rural appraisal and compensation intervention: challenges and protocols while managing large carnivore–human conflict. Human Dimensions of Wildlife 19, 62-71.

Reinhardt I, Rauer G, Kluth G, et al. (2012) Livestock protection methods applicable for Germany - a country newly recolonized by wolves. Hystrix 23, 62-72.

Rigg R, Findo S, Wechselberger M, et al. (2011) Mitigating carnivore–livestock conflict in Europe: lessons from Slovakia. Oryx 45, 272–280.

Salvatori V, Mertens AD (2012) Damage prevention methods in Europe: experiences from LIFE nature projects. Hystrix 23, 73–79.

Wielgus RB, Peebles KA (2014) Effects of wolf mortality on livestock depredations. PLoS One 9, e113505.

Xunta de Galicia (2011) Orden de 23 de diciembre de 2011 por la que se establecen las bases reguladoras de las ayudas para paliar los daños producidos por el lobo, y se convocan para el año 2012. Diario Oficial de Galicia, 248, 40244-40259.

Short Communication

WOLF BEHAVIOUR TOWARDS ELECTRIC FENCES USED IN AGRICULTURE

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1. Introduction

In many regions of Europe, the return of large carnivores regularly leads to livestock damage. This results in discussions regarding risk assessment as well as implementation and financing of protection measures. Fences were previously used to contain livestock; however, electric fences are now also increasingly used as a relatively simple, low-cost method to protect livestock from predation.

Several studies have assessed the effectiveness of electric fences as a damage prevention measure (Cortés, 2007; Liere et al., 2013; Wam et al., 2004), but the behaviour of large predators when encountering such fences is still poorly understood. Some authors have concluded that canines, especially wolves, tend to crawl underneath fences (e.g. Bourne, 2002; Reinhardt et al., 2012). However, based on their personal observations, shepherds have reported that wolves are able to jump over fences, electrified or not, usually when sheep are penned during the night. Such claims raise crucial questions for livestock protection: How do wolves approach a fence and how do they succeed to cross it? Do strategies and behaviour vary between different individuals or packs? What is the role of social learning?

To address these questions a series of experiments was conducted in 2015 by AGRIDEA - Swiss Association for the Development of Agriculture and Rural Areas. The aims of the study were to:

1. gain knowledge about the behaviour of wolves towards three designs of fences that are used in Swiss agriculture;
2. study wolves' strategies to approach, investigate and cross fences;
3. gain insights into the way wolves take advantage of weak points in fencing systems.

2. Study animals

The experiments were conducted in the Sainte-Croix animal park (Rhodes, France) in autumn 2015 with two packs of captive wolves:

- Grey wolves (*Canis lupus lupus*): seven individuals (three males, four females); classic family structure with a well-established hierarchy; the parents were born in 2005 and the offspring in 2010 and in 2012;
- Arctic wolves (*Canis lupus arctos*): seven individuals (four males, three females); six siblings from the year 2014 and an older sister born in 2013.

All individuals were born in captivity, but were not socialized with humans. They showed a natural fear of humans and maintained a distance of approximately 8-15 metres from persons entering their enclosure. There were no neutered individuals in either pack.

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3. Experimental design

The grey wolves were kept in an enclosure of 0.87 hectares, while the arctic wolf enclosure was 0.64 hectares. The wolves were deprived of food for four days prior to the first experiment. Afterwards, meat (beef or poultry, as used for their regular feeding) was placed inside an electric fence for 72 hours. After these three days the wolves were fed normally before starting over with the next experiment. The electric fence was set up as a triangle to facilitate observation and recording: part of the wolves' normal enclosure was used for the two shorter sides and the longer side was formed by the experimental fence (Fig. 1). The length of the tested fence was about 45 metres in the arctic wolves enclosure and about 25 metres in the grey wolves enclosure.

Three remote cameras (in video mode) and two thermal cameras were used to record all experiments in their entirety (Fig. 2). In addition, one person in a hide with a handheld camera filmed the wolves' behaviour during the day. To avoid a "site effect" we investigated if wolves regularly used the experimental areas prior to the experiments. These observations confirmed that wolves frequently passed through the areas where the experiments were set up.

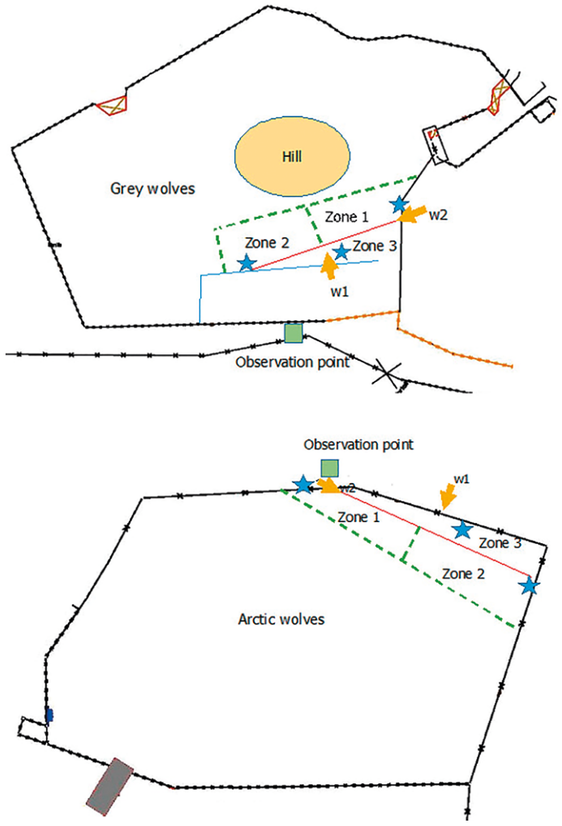


Fig. 1. Enclosures of the two wolf packs studied with indications of the experimental setting.
red line – experimental fence; **yellow arrows w1 and w2** – thermal cameras; **blue stars** – remote cameras; **blue line** – internal fence, non-electrified; **zones 1 and 2** – experimental areas under constant observation/recording by cameras; **zone 3** – area where food was placed during experiments.

Fig. 2. Installation of the camera equipment: remote camera (Bushnell, above) and thermal camera (AXIS Q1921-E, below).

Two designs of fences (Table 1) were tested alternately with each pack and a third design with the arctic wolves only, according to the following sequence:

Experiment 1: Flexinet (electrified net);
Experiment 2: fence with two wires (type A) (Fig. 3);
Experiment 3: Flexinet;
Experiment 4: fence with two wires (type A);
Experiment 5: fence with two wires (type B).

This last test was conducted with the arctic wolves only because construction works within the grey wolf enclosure did not allow completion of the final experiment as originally planned.

Fig. 3. Meat left during an experiment in the grey wolf enclosure. In this case, a two-wire fence was tested. A thermal camera and two remote cameras can be seen, fixed on wooden poles and facing towards the fence or meat.

Table 1. Designs and characteristics of the fences tested.

Fence design	Height (cm)	Colour	Tension (volt) / Amperage (Ø)
Flexinet	90	Orange	V: 3400 / A: 1.7
Fence with two electrified poly wires (type A)	Bottom wire: 25	White and red	V: 3600 / A: 2.0
	Top wire: 65	White and red	V: 3300 / A: 1.9
Fence with two electrified poly wires (type B)	Bottom wire: 35	White and red	V: 3600 / A: 2.0
	Top wire: 80	White and red	V: 3300 / A: 1.9

Voltage and amperage were measured immediately before the start of each experiment as well as afterwards using a Gallagher fence volt/current meter and fault finder (specifications: voltage: 0.2 to 10 kV; current: 1-35 A; battery: CR2032).

After each experiment, all equipment was removed and reinstalled for the next experiment. During the period between experiments wolves were free to roam in their enclosure, including the experimental areas. It can be assumed that the wolves already had some contact with electrified wires in the past, since some parts of their enclosures were additionally secured with one or two such wires inside. Unfortunately, nothing can be said about the details or number of such contacts with electrified wires. However, the fence material we used in our experiments was different from the electrified steel wire already within the enclosures. As far as we know the wolves had not encountered such material before.

Based on observations made during the day, an ethogram was compiled and continuously updated (Fig. 4). The behaviour "obs" was not recorded during the night because the data analysis was conducted by two different persons who carried out video-analyses using slightly different observation protocols. For each behaviour that lasted longer than 3 seconds (e.g. exploring the fence), its duration, frequency and associated posture (e.g. with self-assurance or with caution) was noted. For each behaviour that did not last 3 seconds (e.g. sniffing the ground), only the frequency was noted.

3. Results and discussion

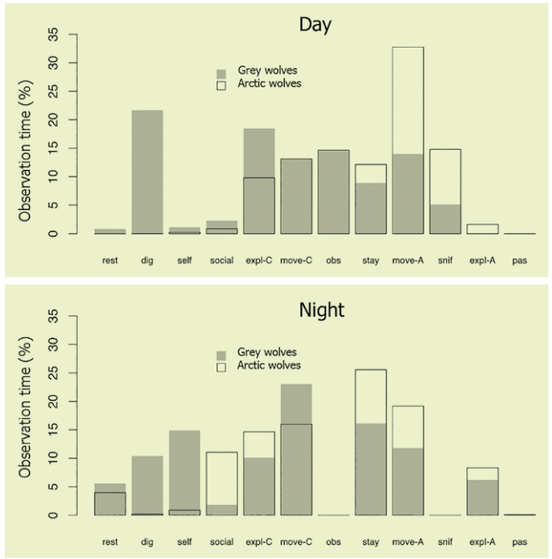
Throughout the experiments, none of the grey wolves and probably only two arctic wolves crossed the test fences. Neither pack attempted to jump over a fence.

The flexinet fence was crossed on three occasions by a single arctic wolf. It may have been the same individual each time, but we were not able to clearly identify individuals with the thermal camera. Due to the elasticity of the net, the wolf managed to pass with a somersault when it ran directly into the net. A wolf damaged the net while getting out and subsequently the fence was left lying on the ground. During the rest of this night the damaged fence was passed six times. This might be a critical starting point for a learning process in how to jump over fences. However, we were not able to investigate this hypothesis further.

The type A fence with wires at 25 cm and 65 cm was not crossed by any wolf. However, the type B fence with wires at 35 cm and 80 cm was crossed by at least two different arctic wolves that crawled under the lower wire a total of nine times. One wolf touched the upper wire with its nose and then rushed through the fence between the wires. On several occasions a wolf that had got inside brought a piece of meat close to the fence and other wolves took it out from the other side. Sometimes a wolf carried a piece of meat back across the fence.

During exploratory behaviour towards experimental fences the wolves' heads pointed mostly straight ahead or downwards (Fig. 5). This suggests that they scanned fences for weak points, particularly on the lower parts. In grey wolves, this tendency was more pronounced when exploring the wire fences than the flexinet-fence. The results with arctic wolves show almost no such effect of the fence design. Furthermore, the following behaviour pattern was generally found before a wolf crossed the fence: after an initial exploration of the fence by several members or the whole pack, social interactions noticeably decreased and the behaviour of the wolves seemed to change from predominantly cautious to a more confident behaviour until one individual crossed the fence. This may have involved habituation (non-associative learning).

In both packs, the frequency of wolf presence close to fences decreased over the three experimental days. Only during experiment 5, in which the bottom wire of the fence had been lifted to a height of 35 cm and a wolf crawled under several times, was the opposite tendency observed (Fig. 6). This suggests that motivation to approach and explore the fence declined over the 72 hours of our experiments if wolves were not able to cross it.



rest – resting;
dig – digging;
self – behaviour relating to the wolf itself such as cleaning, urinating, feeding, etc.;
social – social interaction;
expl-C – exploring the fence with caution;
move-C – moving with caution;
obs – looking in the direction of the fence or over it;
stay – standing around (for at least 3 seconds);
move-A – moving with self-assurance;
snif – sniffing the ground or other elements of the fence;
expl-A – exploring the fence with self-assurance (sniffing or observing);
pas – passing the fence (only occurred in the experiment with the arctic wolves).

Fig. 4. Total time that wolves were observed engaged in various behaviours by pack (grey vs. arctic) during the day and at night.

Fig. 5. An arctic wolf investigating the bottom part of a flexinet. The meat was placed on the left behind the fence.

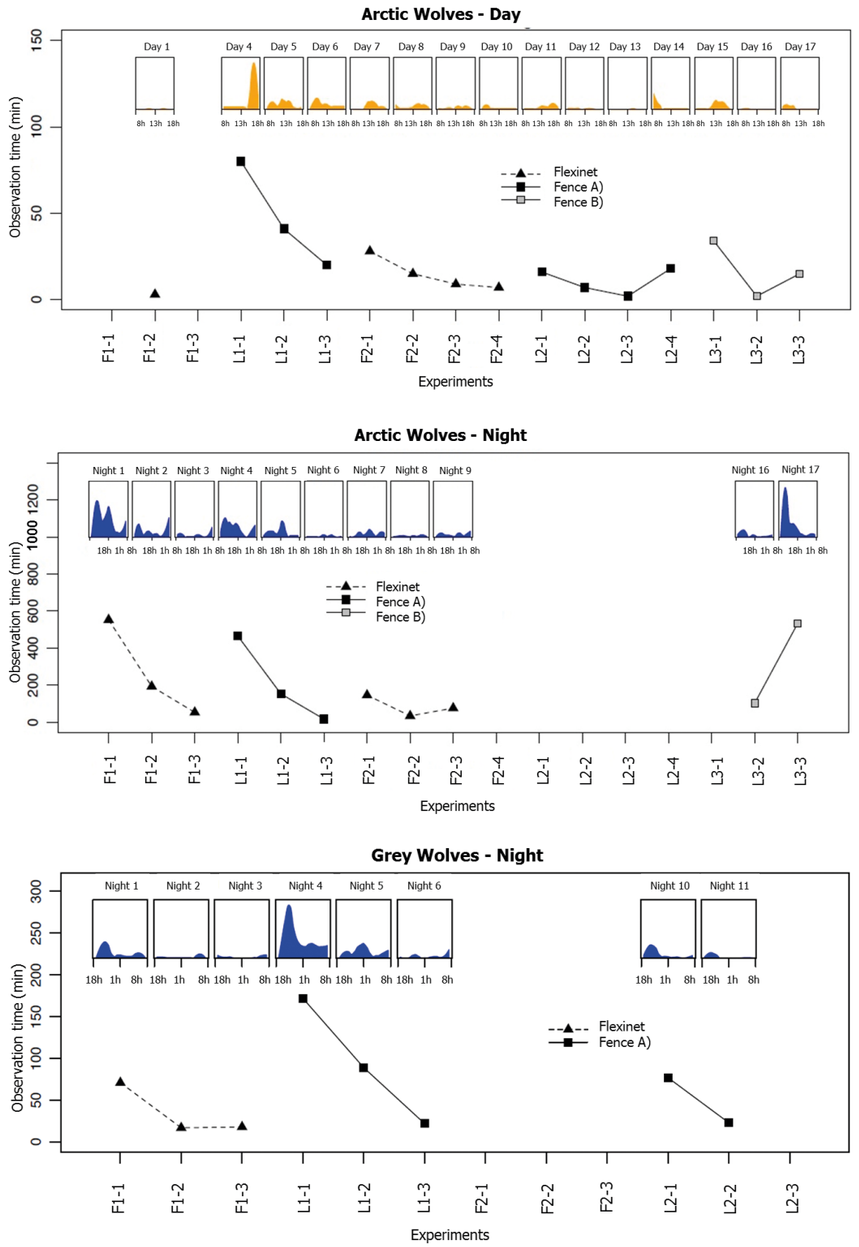


Fig. 6. Frequency of wolf presence at test fences as a function of each experiment for the arctic wolves during the day (top) and at night (middle) and the grey wolves during the night only (there were insufficient approaches to the experimental fence during the day to include in the figure).

F – experiments with the flexinet; L – experiments with a two-wire fence.
The first digit corresponds to the order of the conducted experiments (1 – first time; 2 – second time) and the second digit corresponds to the number of days (top) or nights (bottom) within an experiment (e.g. F2-3 – second experiment with a flexinet, third night). Each experiment included three nights. For the observation time, each minute with wolf presence was summarized for all present wolves (e.g. 100 – one single wolf was present for 100 minutes or five wolves were present together for 20 minutes). In the boxes the distribution of wolf presence is shown as a function of daytime (orange) or night time (blue).

Our observations suggest there could be a correlation between the hierarchical position of an individual and the frequency of the presence of this individual close to the fence. In both packs, a dominant individual was often seen close to the fence (an arctic wolf female and a grey wolf male). However, a dominant female grey wolf was rarely observed near the fence. We did not observe a clear hierarchy among the male arctic wolves. In future research, it would be interesting to study the possible correlation between social status and frequency of exploration. Such data could help understand if and how the behaviour of pack leaders influences other members in their attempts to explore and pass fences.

Fig. 7. A remote camera image of two male grey wolves exploring and digging in front of a type A two-wire fence (top wire 65 cm and bottom wire 25 cm). The meat was on the right behind the fence.

In addition, we also observed clear differences between the two packs: the grey wolves were much more cautious while approaching the fences and tended to stay further from them than the arctic wolves. The latter generally showed more social interactions as well as more explorative behaviour, they more often approached fences during the day and they appeared more confident while doing so. On the other hand, digging in front of the fence was observed among the grey wolves (Fig. 7) but was rare among the arctic wolves.

Once a wolf crossed the fence, other members of the pack became much more focused on that individual. However, it was not observed during any of our experiments that a wolf copied the behaviour of passing the fence after having observed a pack member doing so. Nevertheless, there might be a potential to learn in this way.

4. Final considerations

The insights gained from this study contribute to understanding the behaviour of wolves towards electric fences. Since the experiments were carried out with only two packs of wolves, each of which showed different behaviours, the results should not be generalized. It would be useful to perform similar tests with other wolves in order to further investigate the diversity of behaviours among packs and individuals which could be of significance in their management. Furthermore, it should be noted that there may be considerable differences in the behaviour of captive versus free-ranging wolves. Nevertheless, our findings reaffirm the importance of fence design and invite further research with the aim of providing better information for livestock farmers to increase the effectiveness of predator-exclusion fencing.

References

Bourne J (2002) Electric fencing for predator protection in Alberta. Carnivore Damage Prevention News 5, 9–10.

Cortés Y (2007) Electric fences and conventional fences: a balance of a two year study in Spain. In: Large Carnivores and Agriculture: comparing experiences accross Italy and Europe. International Symposium, Proceedings, pp. 19-20.

Reinhardt I, Rauer G, Kluth G, Kaczensky P, Knauer F, Wotschikowsky U (2012) Livestock protection methods applicable for Germany – a country newly recolonized by wolves. Hystrix 23, 62-72.

van Liere D, Dwyer C, Jordan D, Premik-Banič A, Valenčič A, Kompan D, Siard N (2013) Farm characteristics in Slovene wolf habitat related to attacks on sheep. Applied Animal Behaviour Science 144, 46–56.

Wam HK, Dokk JG, Hjeljord O (2004) Reduced wolf attacks on sheep in Østfold, Norway using electric fencing. Carnivore Damage Prevention News 7, 12-13.

Short Communication

NEOPHOBIA IN CAPTIVE WOLVES EVOKED BY SIMPLE, LOW-COST DISRUPTIVE STIMULI

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1. Introduction

Greater numbers of grey wolves (*Canis lupus*) on the landscape can lead to an increase in the number of livestock depredations (Mech, 1995). A multiplicity of methods exists to prevent livestock depredation by wolves and other carnivore species (Shivik and Martin, 2000; Shivik et al., 2003). Lethal predator control techniques have rarely reduced depredation to an acceptable level, and their use is disfavoured by the public (Shivik et al., 2003; Treves et al. 2016). In addition, traditional non-lethal methods to control predation, such as predator-proof fences, livestock guarding dogs and aversive devices, can be expensive and may not be suitable for every situation.

Novelty (such as novel objects and sounds) can evoke fear in animals (Corey, 1978). In the context of livestock protection, novel elements placed on the landscape can lead wolves to temporarily avoid a problematic area, such as livestock pastures. For example fladry, long ropes with hanging strips of material, has been used as a virtual barrier which wolves tend not to cross (Musiani and Visalberghi, 2001). In case of continuous exposure to a particular object, however, animals usually habituate to it (Corey, 1978).

Predators' responses to low-cost deterrents have seldom been studied. Zarco-Gonzalez and Monroy-Vilchis (2014) studied the effectiveness of low-cost felid deterrents to reduce predation. The effect of fladry on wolves' behaviour and its effectiveness to reduce predation have been assessed (e.g. Musiani and Visalberghi, 2001; Musiani et al., 2003), but little is known about wolves' behavioural response to other low-cost sensory stimuli, including novel objects, sounds and odours. Exploring the effect of various sensory stimuli on wolves' feeding behaviour may help the development of stronger deterrents. The aim of our study was to assess the relative effect of several low-cost, novel sensory stimuli on the feeding behaviour of sub-adult, captive and naïve wolves.

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2. Material and Methods

Tests were conducted on five orphan sibling wolves held in captivity at the Bubonitsy wolf rehabilitation centre, Tver region, Russia. These individuals (two males, three females) were taken from the wild by local people at one month of age and brought to the centre. They were eight months old at the start of our 2-month study. Their behaviour was more similar to free-ranging wolves compared to an adult living in the same enclosure. While the adult had been hand-reared and socialized with humans, contact between the young wolves and people had been minimized and they tended to avoid humans.

Experiments were conducted daily. The five young wolves were tested together in a 4,000 m^2 enclosure. Each day, the adult was isolated in an adjacent enclosure during the experiment and released back into the enclosure afterwards. Individual recognition of the siblings was not possible, so variables were recorded for the group.

2.1. Sensory stimuli tests

As an attractant, we used the same food usually given to the wolves (chicken heads, cow meat and fat), simultaneously spread at four feeding points inside the enclosure. Three points were associated with different sensory stimuli and one was used as a control (no stimulus). Stimuli were placed ≤2 m from the meat. We conducted 2-hour daily trials beginning at 10 am. Between trials, the location of each stimulus was rotated among the four feeding points to avoid site effect bias. After four trials, when each stimulus had been tested at each feeding point, we moved all feeding points to new locations within the enclosure and repeated the trials.

Stimuli tests were terminated when the meat had been consumed at least once for all the stimuli tested. We tested eight different low-cost sensory stimuli (Table 1). These devices were commercially available and were selected to represent a diversity of stimulus properties and activation modes (Fig. 1).

Table 1. Disruptive stimuli tested on five captive wolf siblings.

Stimulus	Characteristics	Referred to in text
Deodorant	Artificial smell, spread around the feeding point up to 1 m.	Artificial olfactory stimulus
Mole repeller	Defenders mega-sonic mole repeller. Aluminium cylindrical post, 50 cm long, 4 cm diameter. Placed next to the meat, hidden under leaves or snow.	Intermittent acoustic stimulus
Hanging aluminium leaves	7 to 10 leaves of 15 x 15 cm, hung on low branches (up to 50 cm above the ground) and spread around feeding point up to 1 m. In motion through wind activation.	Permanent visual stimulus
Radio	Constant background noise from the radio. Maximum volume.	Permanent acoustic stimulus
Motion-activated white light	Ovoid white light, 20 x 10 cm. Activation within 5 to 10 m, for 90 seconds. Intensity of 50 to 60 lm.	Movement-activated visual stimulus
Flashing red light	Headlamp; flashing point of red light.	Intermittent visual stimulus
Burnt sheep wool	Organic smell, spread in 4 points around the feeding point, up to 1 m.	Organic olfactory stimulus
Motion-activated ultrasound	Weitech WK0051 - Garden Protector. Activation up to 16 m, for 7 seconds. Re-activation after 5 seconds if motion still detected. Red light when activated. Frequency = 24 kHz.	Movement-activated ultrasonic stimulus

Fig. 1. Commercially available electronic devices tested for their influence on the behaviour of captive wolves: Weitech WK0051 Garden Protector (top left), radio (top right), motion-activated white light (bottom left) and Defenders mega-sonic mole repeller (bottom right).

In December 2015 we tested the reaction of wolves to deodorant, mole repeller and aluminium leaves. In January 2016 we tested the reaction of wolves to a radio, a motion-activated light and motion-activated ultrasound. After the first trial showed the motion-activated light to be unsuccessful in repelling wolves, we used this feeding point for exploratory testing of other new stimuli: a flashing red light and the smell of burnt sheep wool. A 2-week break was taken between the first experimental period in December and the second experimental period in January, in order to minimize the effect of stimuli testing in the first period on results from the second period.

Trials were conducted without human presence. Activity around each feeding point was recorded using remote cameras (Moultrie A-5 Digital Game Camera, Birmingham, USA; Tasco 119215C Digital Scouting Camera, Cody, USA). Cameras were set facing the feeding points. They were placed 5-6m away from the stimuli and 2-3 m above the ground to minimize their visibility and impact on the wolves' behaviour. Moreover, the wolves had been habituated to remote cameras prior to this experiment, as their behaviour was recorded throughout the rehabilitation process. Recordings made at the control feeding points also allowed us to confirm that cameras did not have any impact on wolves' feeding behaviour. Wolves were fed (2 kg per wolf, corresponding to the daily food requirements of sub-adult wolves) at the end of each trial if the attractant remained untouched.

For each feeding point and trial, we scored: whether the meat had been consumed; the number of wolves consuming it; the number of wolves approaching it; the number of approaches before consumption; times to first pre-sampling, first approach, and first consumption. A wolf was considered to have approached a feed-

ing point when it was c. 1 m from the feeding point. Pre-sampling activities were defined as including looking at the meat, sniffing towards the meat and scratching the ground close to the meat.

2.2. Data analysis

Data were analysed in Microsoft Excel 2016 for Mac (version 15.25.1, Microsoft Corporation, Redmond, WA, USA) and R for Mac (version 3.3.1, R Foundation for Statistical Computing, Vienna, Austria). Time to first consumption, approach and pre-sampling in the sensory stimuli tests were given a maximum value equivalent to the full trial duration (i.e. 120 min) if the attractant was not consumed, approached or pre-sampled. Means and standard deviations of the time to first consumption and time to first approach for the first and second experimental periods were calculated. In addition, we used Principal Component Analysis (PCA) to assess which variables were correlated and to uncover factors associated with wolf response to novelty. We computed four PCAs in R using the FactoMineR package. One PCA was computed per feeding point of the first experimental period using six quantitative variables: time to first pre-sampling; time to first approach; time to first consumption; number of approaches; number of wolves approaching; and trial number.

3. Results

3.1. Sensory stimuli - Experimental Period 1

The first experimental period unfolded over 12 trials (Table 2). Attractants at the control feeding point and the feeding point associated with an artificial olfactory stimulus were consumed during every trial. The feeding point associated with a permanent visual stimulus was approached by a wolf during trial 2, and the feeding point associated with an intermittent acoustic stimulus was approached by a wolf during trial 3, but these approaches did not result in consumption (Fig. 2). Wolves approached these feeding points inconsistently during subsequent trials. The attractant associated with an intermittent acoustic stimulus was consumed after eight trials. The last feeding point at which the attractant was consumed, after 11 trials, was the one associated with a permanent visual stimulus. Following first consumption, wolves consumed attractants at these feeding points sporadically.

Table 2. Occurrence of consumption (C) and approach (A) across trials and by type of stimulus; consumption involves approach.

Trial number	Control	Artificial olfactory	Intermittent acoustic	Permanent visual
1	C	C	-	-
2	C	C	-	A
3	C	C	A	A
4	C	C	-	-
5	C	C	-	-
6	C	C	-	-
7	C	C	A	A
8	C	C	C	-
9	C	C	C	A
10	C	C	-	-
11	C	C	-	C
12	C	C	C	-
Total C	12	12	3	1
% of trials during which consumption occurred	100%	100%	25%	8%

Fig. 2. Juvenile wolf in captivity showing neophobic response to aluminium leaves.

Over the 12 trials, the average latencies to approach and consume attractants were the longest for the permanent visual stimulus ($\overline{X}$=110.1±8.9 and $\overline{X}$=115.1±8.2 respectively), followed by an intermittent acoustic stimulus ($\overline{X}$=71.7±21.9 and $\overline{X}$=106.3±12.9), the control feeding site ($\overline{X}$=26.3±15.7 and $\overline{X}$=27.0±16.3) and an artificial olfactory stimulus ($\overline{X}$=15.5±6.5 and $\overline{X}$=15.8±6.7).

PCAs with scores from 12 trials on six variables resulted in three components accounting for >80% of observed variance. For all feeding points, latencies to approach, consume and pre-sample were positively correlated. These latencies were negatively correlated with number of wolves approaching for the permanent visual stimulus and for the intermittent acoustic stimulus. Late trials were associated with fewer approaches for the permanent visual stimulus and with more wolves approaching for the control. Late trials were associated with shorter latencies to consume for the intermittent acoustic stimulus.

3.2. Sensory stimuli - Experimental Period 2

The second test period lasted for four trials (Table 3). After trial 4, the attractants at each feeding point had been consumed at least once.

Table 3. Occurrence of consumption (C) and approach (A) across trials and by type of stimulus; consumption involves approach.

Trial number	Control	New stimuli (light/odour)	Movement-activated ultrasounds	Permanent acoustic
1	C	C	C	-
2	C	C	C	-
3	C	C	C	C
4	C	C	C	C
Total C	4	4	4	2
% of trials during which consumption occurred	100%	100%	100%	50%

The last attractant to be consumed was associated with a permanent acoustic stimulus. Attractants at the control feeding point and at feeding points associated with new stimuli and ultrasound were consumed on every trial. The feeding point associated with a permanent acoustic stimulus was only approached by wolves and the attractant consumed on trials 3 and 4.

On average, wolves took longest to approach the feeding point associated with a permanent acoustic stimulus ($\overline{X}$=60.8±29.6), followed by new stimuli ($\overline{X}$=24.25±18.4), ultrasound ($\overline{X}$=16.5±8.9) and the control feeding point ($\overline{X}$=4.5±0.6). The attractant associated with a permanent acoustic stimulus was also the last to be consumed ($\overline{X}$=60.8±29.6), followed by ultrasound ($\overline{X}$=35±21.9), new stimuli ($\overline{X}$=25.5±18.4) and the control ($\overline{X}$=4.5±0.6).

4. Discussion

4.1. Wolf reaction to novel stimuli

Field investigations of uncombined visual or acoustic stimuli is almost non-existent for wolves, except regarding fladry tests, the results of which have been highly variable depending on test conditions. In penned experiments, wolves seemed to habituate to fladry after one day of exposure (Lance et al., 2010), whereas in free-ranging conditions it remained efficient for up to 90 days (Gehring et al., 2006). Regarding intermittent acoustic stimuli, tests on coyotes indicated that propane explosions could deter predation in free-ranging conditions for 1 to 180 days (Pfeifer and Goos, 1982).

Some authors have thought motion-activated stimuli to be more effective than permanent and intermittent stimuli (Shivik and Martin, 2000). However, we found that motion-activated and intermittent lights, as well as permanent acoustic stimulus (radio) and behaviour-contingent ultrasound were poor repellents compared to permanent visual and intermittent acoustic devices. This suggests that wolves' level of neophobic behaviour toward a stimulus may depend more on the properties of the stimulus rather than its activation mode (Harris and Knowlton, 2001). In our trials, the permanent visual stimulus (aluminium leaves) tested in the first experimental period elicited the longest neophobic reaction, with highest latencies to approach and consume, followed by the intermittent acoustic stimulus (mole repeller).

We observed that olfactory stimuli, either organic or artificial, were ineffective at evoking a neophobic reaction from wolves, which is in agreement with most previous studies (e.g. Harris and Knowlton, 2001 - for coyotes). We further observed that mean latencies to approach and to consume were even smaller for artificial olfactory treatment than for the control, supporting the suggestion that such stimuli might elicit approach instead of the intended avoidance (Harris and Knowlton, 2001). Attractiveness of olfactory stimuli might be related to the scent-rubbing behaviour of wolves. Manufactured odours such as deodorant or perfume were reported to elicit the strongest rubbing response by wolves (Ryon et al., 1985), which might explain the attractiveness of feeding points associated with artificial olfactory stimuli in our study.

Finally, many studies have found ultrasound to be ineffective as a repellent (e.g. Edgar et al., 2007 - for dingoes). The assertion that ultrasound is a stronger repellent than sounds audible to humans has yet to be confirmed and might be erroneous (Bomford and O'Brien, 1990). The use of ultrasound as a repellent has seldom been studied in wild canids. Our results indicate that 24 kHz motion-activated ultrasounds are ineffective at repelling captive sub-adult wolves.

4.2. Wild vs. captive individuals

Wolves seem to habituate to fladry faster in penned experiments than in free-ranging conditions (Gehring et al., 2006; Lance et al., 2010). This might be due to the fact that captive wolves are reared in an enriched environment, reducing their later level of neophobia (Corey, 1978; Greenberg, 2003). In addition, captive wolves in permanent contact with fladry during experiments have more opportunity to learn than wild wolves passing by the fladry line, and hence may habituate quicker. The young wolves in our study had known human handling, social interactions and visual variety from a young age, although such interactions were kept to a minimum within the rehabilitation process. Such early stimulation may have led to them being less fearful and more exploratory during tests (Corey, 1978). On the other hand, free-ranging juveniles may have to explore more unpredictable and dangerous territories, reducing their level of neophobia compared to captive individuals raised in safer conditions (Greenberg, 2003). Variation in wild wolves' level of neophobia depends on the interaction between their environment and juvenile exploration.

4.3. Neophobia vs. exploration

Our results indicate that wolves both investigated and avoided novel permanent visual and intermittent acoustic stimuli, as no consumption was undertaken despite variable latencies to approach or pre-sample over the trials. Novel objects can elicit animal reactions that range from curiosity to anxiety (Corey, 1978; Greenberg, 2003; Harris and Knowlton, 2001). Moretti et al. (2015) found that wolves displayed a greater interest in novelty, but also greater neophobia than domestic dogs. In the present study, wolves seemed to be more perseverant in approaching an intermittent acoustic stimulus than a permanent visual stimulus, as: 1) shorter latencies to approach were associated with a higher number of approaches for the acoustic stimulus, but not for the permanent visual stimulus; 2) consumption tended to occur faster over the trials for the acoustic stimulus; and 3) the number of approaches tended to decrease over trials with the visual stimulus. It has been shown that juveniles tend to have a spontaneous attraction to novel objects and a lower neophobic response (Greenberg, 2003). The young age of our experimental animals might thus have led them to adopt more exploratory behaviours than adult wolves.

4.4. Individual variation

We were not able to study individual variation in response to novelty, but this could be an important aspect to consider when studying neophobia. Each individual tends to react differently to novelty due to differences in personality and experience. Behavioural differences are also related to the social status of individuals within a group. For example, during pairs' tests, dominant coyotes were found to be less neophobic, thus taking more risks, than subordinates coyotes in novel settings (Mettler and Shivik, 2007).

In addition, the presence of an experienced adult may facilitate learning (Galef and Laland, 2005). The young wolves involved in the present study were not exposed to novelty alongside an experienced adult (i.e. an adult already habituated to the devices tested). Free-ranging juveniles, on the other hand, usually have the opportunity to learn from experienced parents.

4.5. Group effect

Longer latencies to approach tended to be associated with fewer wolves approaching for the permanent visual stimulus and for the intermittent acoustic stimulus, implying a possible group effect in wolves' neophobic reaction. Moretti et al. (2015) observed that wolves manipulated a novel object more when in a group than alone. Such social facilitation was effectively observed throughout the tests, but no definitive conclusion can be drawn from our group sample size (n=1).

4.6. Use of senses during predation

Wells and Lehner (1978) suggested that the most significant senses used during predatory behaviour might be more susceptible to the corresponding aversive stimuli. They asserted that vision was the most important sense during coyote predation, followed by audition. This would be consistent with our own findings regarding wolves' level of neophobia towards auditory and visual stimuli. In addition, different stimuli may be more effective during different phases of the predation sequence. Visual cues are the strongest releaser of prey capture in foxes, but they rely mostly on audition to locate prey (Osterholm, 1964). We found that novel visual stimuli placed close to an attractant evoked the strongest neophobic reaction in wolves. By ordering wolves' sensory importance during the hunt, and understanding at which scale of the anthropogenic landscape these senses intervene, it might be possible to create discomfort areas around livestock using low-cost stimuli and thus selectively reduce wolf predatory activity on the landscape.

4.7. Recommendations for further research

Caution should be exercised when interpreting results from experiments in captivity, as captive conditions differ from free-ranging conditions. Biases caused by socialization, exposure to an enriched environment, restrained group dynamics and regular feeding should be taken into account. Thus, the results of our study cannot be extrapolated to free-ranging conditions. Nevertheless, our results help clarify hypotheses and topics for further research and possible field trials. Studying wild wolves' behaviour requires time and, in many cases, expensive equipment. Experiments in captivity are easier to implement and can give primary indications on general wolf behaviour that could subsequently be applied to experiments in the wild.

Explorative studies of various deterrents are quite challenging. Indeed, it is difficult to test large numbers of novel stimuli on a single wolf group, as they may gradually habituate to novelty and integrate it as part of their environment. This is especially true in captive conditions, as wolves are continuously exposed to novel objects and their responses may therefore quickly diminish. We decided to test eight stimuli that were quite different in nature and made broad conclusions on the relative effect on wolf behaviour of various visual, olfactory and acoustic stimuli. For future research, however, we recommend focusing on comparing specific stimulus properties, such as comparing the effect of visual stimuli size or sound stimuli volume, in order to refine conclusions. Various factors, unrelated to stimulus properties, should also be investigated to clarify their effect on wolves' neophobia, such as

rotating stimuli to delay habituation, the influence of conspecifics and familiarity with the environment.

5. Conclusions

We believe there is potential for low-cost deterrents to effectively repel predators and alleviate the cost of livestock protection. We found that neophobic responses of wolves were highly dependent on the properties of the novel stimuli to which they were exposed. In our trials, simple permanent visual and intermittent acoustic stimuli evoked stronger neophobic responses from a group of captive wolves than permanent acoustic stimuli, lights, olfactory and ultrasonic cues. We suspect a group effect and individual boldness to have influenced wolf behaviour in this study. Many other variables are important to consider in relation to free-ranging wolves' neophobic response to simple stimuli. We recommend conducting further explorative studies of wolf deterrents to help elucidate key properties for low-cost disruptive devices.

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References

Bomford M, O'Brien PH (1990) Sonic deterrents in animal damage control: A review of device tests and effectiveness. Wildl. Soc. Bul. 18, 411–422.

Corey DT (1978) The determinants of exploration and neophobia. Neurosci. Biobehav. Rev. 2, 235–253.

Edgar JP, Appleby RG, Jones DN (2007) Efficacy of an ultrasonic device as a deterrent to dingoes (*Canis lupus dingo*): A preliminary investigation. J. Ethol. 25, 209–213.

Galef BG, Laland KN (2005) Social learning in animals: Empirical studies and theoretical models. BioScience 55, 489–499.

Gehring TM, Hawley JE, Davidson SJ, Rossler ST, Cellar AC, Schultz RN, et al. (2006) Are viable non-lethal management tools available for reducing wolf-human conflict? Preliminary results from field experiments. In: Proceedings of the 22nd Vertebrate Pest Conference, pp. 2–6.

Greenberg R (2003) The role of neophobia and neophilia in the development of innovative behaviour of birds. In: Reader SM, Laland KN, editors. Animal innovation. Oxford University Press, New-York, pp. 175-196.

Harris CE, Knowlton FF (2001) Differential responses of coyotes to novel stimuli in familiar and unfamiliar settings. Can. J. of Zool. 79, 2005–2013.

Lance NJ, Breck SW, Sime C, Callahan P, Shivik JA (2010) Biological, technical, and social aspects of applying electrified fladry for livestock protection from wolves (*Canis lupus*). Wildl. Res. 37, 708–714.

Mech LD (1995) The challenge and opportunity of recovering wolf populations. Conserv. Biol. 9, 270–278.

Mettler AE, Shivik JA (2007) Dominance and neophobia in coyote (*Canis latrans*) breeding pairs. Appl. Anim. Behav. Sci. 102, 85–94.

Moretti L, Hentrup M, Kotrschal K, Range F (2015) The influence of relationships on neophobia and exploration in wolves and dogs. Anim. Behav. 107, 159–173.

Musiani M, Mamo C, Boitani L, Callaghan C, Gates CC, Mattei L, et al. (2003) Wolf depredation trends and the use of barriers to protect livestock in Western North America. Conserv. Biol. 17, 1–10.

Musiani M, Visalberghi E (2001) Effectiveness of fladry on wolves in captivity. Wildl. Soc. Bul. 29, 91–98.

Osterholm H (1964) The significance of distance receptors in the feeding behaviour of the fox, *Vulpes Vulpes*. Acta Zool. Fenn. 106, 1–31.

Pfeifer WK, Goos MW (1982) Guard dogs and gas exploders as coyote depredation control tools in North Dakota. In: Proceedings of the 10th Vertebrate Pest Conference, pp. 55–61.

Ryon J, Fentress JC, Harrington FH, Bragdon S (1985) Scent rubbing in wolves (*Canis lupus*): the effect of novelty. Can. J. Zool. 64, 573–577.

Shivik JA, Martin DJ (2000) Aversive and disruptive stimulus applications for managing predation. In: The 9th Wildlife Damage Management Conference Proceedings, pp. 111–119.

Shivik JA, Treves A, Callahan P (2003) Nonlethal techniques for managing predation: primary and secondary repellents. Conserv. Biol. 17, 1531–1537.

Treves A, Krofel M, McManus J (2016) Predator control should not be a shot in the dark. Front. Ecol. Environ. 14, 380–388.

Wells MC, Lehner PN (1978) The relative importance of the distance senses in coyote predatory behaviour. Anim. Behav. 26, 251–258.

Zarco-González MM, Monroy-Vilchis O (2014). Effectiveness of low-cost deterrents in decreasing livestock predation by felids: A case in Central Mexico. Anim. Conserv. 17, 371-378.

Short Communication

PREPARING FOR THE INCREASING PRESENCE OF LARGE PREDATORS IN SOUTH TYROL: A CHALLENGE FOR ALPINE FARMING

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1. Introduction

In South Tyrol, Italy, wolves were officially eradicated in 1896 and brown bears in 1930 (AF, 2016a), although unconfirmed chronicles mention the presence of brown bears in the province until the 1970s. However, increasing populations of wolves and bears in Switzerland and Slovenia as well as adjacent Italian provinces (AGRIDEA, 2016a,b,c) raise the possibility of their reestablishment in South Tyrol (Fig. 1). The renewed presence of bears has been documented for more than ten years, particularly in western parts of the province (AF, 2016a). The wolf has also been recorded regularly since its return was genetically confirmed for the first time in 2010 (AF, 2016a).

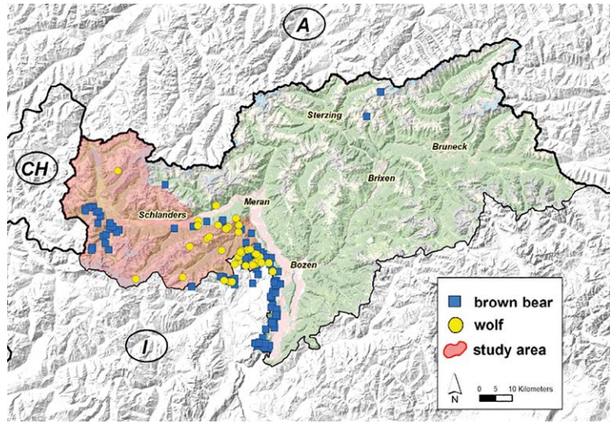

Fig. 1. Records of the presence of wolf and brown bear in South Tyrol, Italy, 2013-2015.

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The first damage to livestock by large predators returning to South Tyrol was confirmed in 2005 (Table 1). Alpine farming is highly valued in the province and around 95,000 farm animals spend the summer on alpine pastures every year (AF, 2016b). The increasing presence of wolves and bears raises the risk of further damages. Small livestock traditionally graze vast pastures in high altitudes in a free grazing system. Here, the danger of being attacked by large predators is especially high and damages at least by wolves are expected to be most likely on sheep, the most abundant species.

Table 1. Number of livestock killed by large predators in South Tyrol in 2005-2015.

	Brown bear	Wolf		
Year	Livestock*	Sheep	Goat	Cattle
2005	65	0	0	0
2006	4	0	0	0
2007	104	0	0	0
2008	43	0	0	0
2009	24	0	0	0
2010	56	12	2	2
2011	14	0	4	1
2012	31	0	0	0
2013	5	0	0	0
2014	6	19	0	0
2015	9	15	4	0
Total	**362**	**46**	**10**	**3**

*No data available for the separation into different livestock categories.

The increasing presence of large predators has usually been met with incomprehension by the rural populace, especially owners of small livestock and alpine farmers. The development implies change processes (e.g. adaptations in managing small livestock alpine farming systems / small livestock husbandry) and thus causes complications in the everyday working life of affected players. Knowledge as well as experience to handle the expected changes are lacking which results in uncertainty concerning the maintenance of small livestock husbandry and small livestock alpine farming. Affected players are unsure how to handle the new situation. Even for the administration and consultants the coexistence of large predators and livestock is new and they also lack necessary experience.

To address this issue, the Bolzano Agency for Hunting and Fishing (Amt für Jagd und Fischerei Bozen) and Stilfserjoch National Park (Nationalpark Stilfserjoch) commissioned a study on small livestock alpine farming in western South Tyrol (Moser et al., 2016). This study, developed by Büro Alpe and AGRIDEA in 2015, had three main goals:

1. To document the current situation of small livestock on alpine farms and pastures and elaborate possible adaptations of the alpine farming system and measures to protect flocks;
2. To analyse affected players and present structures of small livestock husbandry and small livestock alpine farming;
3. To develop a proposal to establish an advisory centre.

Here we present the main results of this study.

2. Study area and methods

The study was conducted in the western part of South Tyrol (Fig. 1), in the district of Vinschgau, in Ultental, Deutschnonsberg and Tisens. From July to September 2015 more than 30 alpine farms and pastures with small livestock were inspected together with representatives of the Department of Forestry as well as the owners of alpine farms and pastures and those who manage them (alpine farmers) (Fig. 2). The study focused on alpine sheep farming, because in the study area the number of sheep grazing on alpine farms and pastures (about 1,760 livestock units, LU, in 2014) exceeds that of goats (about 380 LU in 2014) considerably (FU, 2014). Up to now, sheep have been attacked by wolves more often than goats on alpine farms and pastures (AF, 2016a; Table 1).

Face-to-face interviews were conducted with different affected players (e.g. owners of small livestock, owners of alpine farms, alpine farmers) in order to analyse their roles, interests and motivations as well as the interactions between them concerning small livestock husbandry and small livestock alpine farming. Furthermore, existing structures of small livestock husbandry and small livestock alpine farming (e.g. ownership structures at alpine farm level and responsibilities at administration level) were analysed.

Fig. 2. Participants of an alpine farm inspection in the valley of Martell, South Tyrol, 2015. Photo: Cornel Werder.

3. Results

3.1. Small livestock husbandry and small livestock alpine farming

The average number of small livestock per farm in the study area was 16 sheep and 9 goats (TDM, 2016). In most cases, these consisted of regional mountain breeds rather than of economical meat breeds, underlining the traditional, sentimental and intangible value of small livestock husbandry and small livestock alpine farming for most owners. In general, owners wanted to maintain small livestock husbandry and small livestock alpine farming, but the legal protection status of large predators and their increasing presence in the study region oblige them to apply certain changes.

Currently, small livestock alpine farming is characterised by free grazing without the use of any fences on vast open terrain at high altitudes (Fig. 3). In terms of livestock units, there were around 2,100 LU small livestock on alpine farms in 2014, compared to 5,700 LU heifers and calves and 1,670 LU dairy cows (FU, 2014). Due to the current system of free grazing, the workload of small livestock alpine farming is rather low. On the other hand, this system makes it difficult to implement controlled pasturing and measures to protect flocks.

Fig. 3. Free grazing sheep at high altitudes without fences, Waldner Laugenalm alpine farm, South Tyrol, 2015. Photo: Simon Moser.

Fig. 4. Use of fencing to control grazing at high altitudes, Erigsmatt alpine farm, Switzerland, 2014. Photo: Cornel Werder.

An analysis of small livestock husbandry and individual alpine farms and pastures shows that it is not possible to implement measures to protect flocks quickly due to the structure of small livestock husbandry and small livestock alpine farming: many different livestock owners with small flocks, mainly mixed alpine farming systems with different livestock categories and predominantly free grazing system of small livestock on alpine farms and pastures. Considering these structures in small livestock alpine farming, if a solution to meet the increasing presence of large predators on the farm level is not feasible, it may be reasonable to create regional management plans that may include several alpine farms and pastures as well as currently ungrazed areas at lower altitudes, and may also consider reorganisation (including fusion) of alpine farms.

Fig. 5. Productive pastures at low altitudes on the slope between Laas village and the first forest belt, district of Laas, South Tyrol, 2015. Photo: Daniel Mettler.

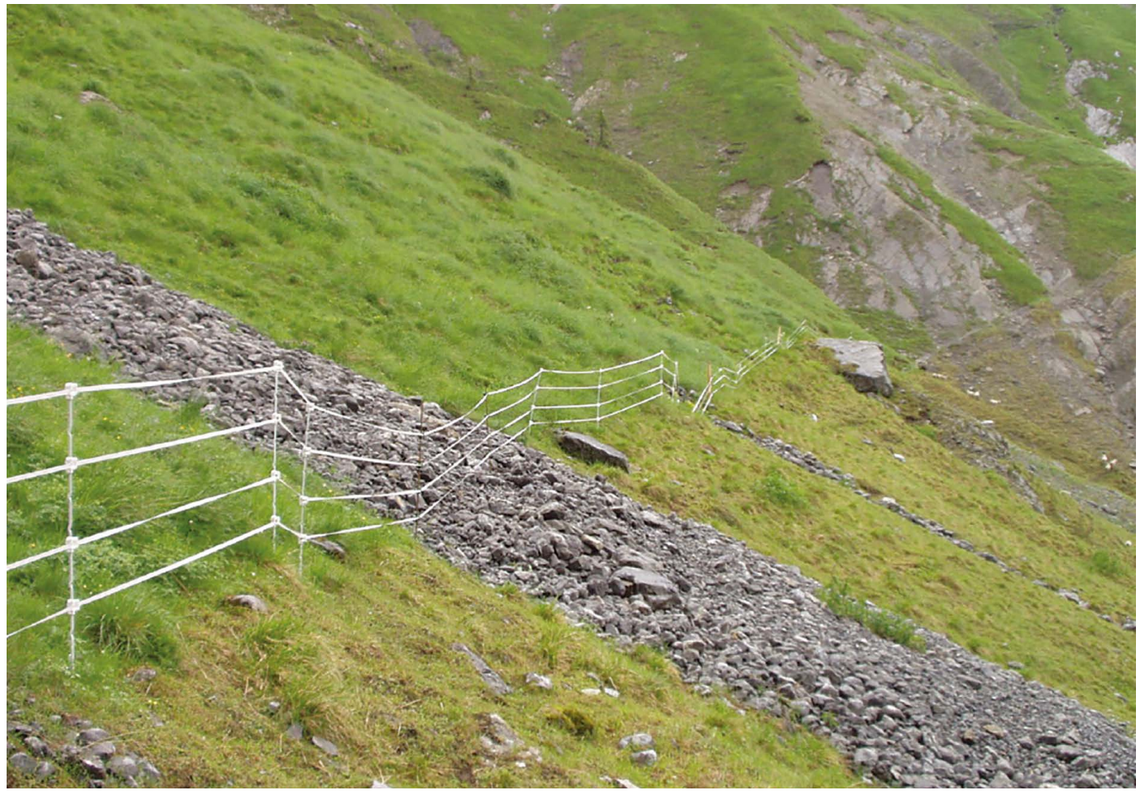

Fig. 6. Horizontal electric fences to ensure better use of forage potential, Oberarni Wolfenschiessen alpine farm, Switzerland, 2004. Photo: Cornel Werder.

It is generally recommended to begin adapting the alpine farming system in a first step to prescribed pasturing: systematic management of pastures in smaller sections to maintain natural resources and to keep the animals closer together. The most important aspect of prescribed pasturing is to restrict the free grazing of sheep on pastures (Fig. 4). Electrically fenced and productive pastures at lower altitudes are needed during spring and autumn (Fig. 5) and large pasture sectors limited either naturally (e.g. by steep rocky slopes) and/or by electric fences at higher altitudes in summer. Spatial limitation of pastures facilitates control of livestock, rapid detection of predation and homogeneous herd formation. Therefore, animals need to be checked regularly by shepherds. Furthermore, spatial limitation of pastures prevents sheep from grazing mainly the highest areas and thus ensures a better utilisation of the given forage potential as well as reducing erosion (Fig. 6). Prescribed pasturing also enables the implementation of measures to protect the flock in a second step if needed.

Fenced and productive pastures at lower altitudes can provide a temporary emergency refuge in case of large predator attacks during summer to avoid premature termination of the ongoing grazing season. Sheep can be gathered there to gain control and implement flock protection measures such as night-time corrals or livestock guarding dogs. Implementation and supervision of such emergency flock protection measures is more feasible in small, fenced lowland pastures than in large pasture sectors in high altitudes due to their easier accessibility.

Temporary emergency measures provide the opportunity to develop and implement an individual strategy for the affected alpine farm. Once alpine farming systems have been adapted to prescribed pasturing, the next step towards controlled pasturing, which includes the continuous presence of shepherds with herding

dogs as well as temporary or continuous integration of flock protection measures, can be implemented more easily. Such a step-by-step adaptation of the grazing system is made possible by the currently still relatively low predation pressure.

3.2. Affected players

The most affected players in connection with the increasing presences of large predators are of course alpine farm owners, alpine farmers (managers of alpine farms), and small livestock owners. As large predators are protected by law, their increasing presence calls for adaption of the alpine farming system if affected players want to maintain small livestock alpine farming. The amount of personnel, workload, equipment and finances required depends on the individual alpine farm and the desired extent of change. It is crucial for the willingness and motivation of the affected players to implement change, but information and experience referring to the amount of additional investment is lacking. This is one of the main reasons why the general attitude of affected players remains sceptical and observant.

3.2.1. Owners of alpine farms

Owners of alpine farms in the study area are mainly (>80%) public communities or private associations, but not private farmers (AB, 2011). Alpine farming often represents an important part of the activity of these communities or associations. Furthermore, the regional agricultural structure (livestock husbandry and alpine farming vs. fruit cultivation) as well as the importance of alpine farming for the general public, authorised users and co-owners of alpine farms are crucial for the priority of alpine farming within communities or associations. The majority of communities and associations in the study area are generally interested in maintaining alpine farming. Communities or associations are usually not profit-orientated, positive about alpine farming and have a collective responsibility for financial expenses. Thus they generally represent a better prerequisite for implementing change than single private owners. Within the ownership of alpine farms, the agricultural orientation of the key decision-makers (cattle farmer, small livestock farmer, fruit farmer) is crucial for the willingness of those individuals and therefore of the communities or associations to contribute to change.

3.2.2. Alpine farmers

More than 80% of alpine farms and pastures in the study area are managed by the owners themselves or by use of exploitation rights (AB, 2011). Generally, this circumstance is also a good prerequisite to apply change processes, as usually they have a deep identification with their profession and region. For alpine farmers, the amount and importance of small livestock on their specific alpine farm plays a crucial role in their attitudes towards change processes. In case of adaption of the alpine farming system due to the increasing presence of large predators, alpine farmers are the most directly affected players. Their workload will clearly increase, both temporarily at the beginning of the grazing season as well as throughout the whole summer grazing period.

3.2.3. Small livestock owners

For the majority of small livestock owners, both husbandry as well as alpine farming of sheep and goats have a long tradition and represent a sentimental and intangible value. Thus, their general motivation to keep them alive is high. Small livestock owners pursue different strategies to protect their flocks during summer depending on their relation to alpine farms and pastures. In case of strong identification with a specific alpine farm and pasture due to exploitation rights or co-ownership, owners tend to accept (though not welcome) change processes and efforts to protect their animals on this specific alpine farm. If such identification is lacking, they may either switch to a different farm in a region where there have been no large predators so far, or switch to another alpine farm where flock protection is already established.

3.3. Administrative structures

3.3.1. Current administration

Different offices and responsible persons are confronted with the issues of alpine farming and large predators. Most tasks lie within the jurisdiction of the Department of Forestry. The Agency for Hunting and Fishing (Amt für Jagd und Fischerei) is responsible for the management of large predators and the Agency for Mountain Management (Amt für Bergwirtschaft) is responsible for specific duties concerning consultation and awarding subsidies in connection with alpine farming. The different forest inspectorates and forest warden stations execute a control function regarding current legal provisions of alpine farming.

An analysis of administrative structures shows that the management of large predators is logically positioned at the Agency for Hunting and Fishing, as it is part of the protection of wild animals. The question of which department is responsible for the protection of livestock against large predators is not sufficiently clear at present. This responsibility should not be part of either the Hunting Agency or of environmental agencies/associations, because both are already charged with protecting wild animals so conflicts of interest could emerge. Another reason is that hunting, farming and the environment are all different areas of expertise and therefore hard to combine appropriately. Therefore protection of livestock should be designated to the Agencies of Agriculture or Mountain Management, as their expertise is agriculture, alpine farming and livestock. Furthermore, this would probably strengthen the acceptance of farmers, who have often had historical tensions with the hunting and environment agencies.

3.3.2. Advisory centre

There is a need for an advisory centre to inform affected players and those interested in the return of large predators. Such a centre could be implemented within the scope of the Agriculture or Mountain Management administration or it could be outsourced and established as an external structure. To ensure the independence of such an advisory centre, it should not be directly involved in the execution and control of current regulations concerning alpine farming. In the present situation, the main objective of this advisory centre should be providing know-how to affected players thereby following a practically oriented and participative approach.

4. Discussion

The currently widespread alpine farming system of free grazing of small livestock requires a rather low workload. It is therefore very attractive for alpine farmers and small livestock owners. However, experience from Switzerland (AGRIDEA, 2016a; Mettler et al., 2014; Werder and Bamert, 2015) shows that this system of alpine farming probably cannot be maintained in case of increasing pressure from large predators, as it is not conducive to adequate protection of livestock.

We found a certain level of scepticism among alpine farmers and small livestock owners to change from free grazing to a prescribed pasturing system, as suggested by the current study. The free movement of animals on alpine pastures is considered by small livestock owners to be indispensable for successful alpine farming and the advantages of an adapted alpine farming system are not obvious to them at present. Besides, the amount of financial and personnel investment that accompany change processes in alpine farming systems is unclear and difficult to assess by the affected players. There is a clear need for advice, as the level of investment will surely influence willingness and motivation to implement change. Additionally, as predation pressure is still rather low, with only sporadic attacks, there is currently no acute need for action. These different aspects create an overall insecurity and result in an observant attitude of the affected players rather than taking an active role. Now is the ideal time to start step-by-step preparations for increased danger to small livestock on alpine pastures in the future, but the opportunity is not being used.

In the current situation, establishment of an advisory centre to assist affected players should be a first priority. On the one hand, this would provide farmers and livestock owners with the opportunity to inform themselves about adapted alpine farming systems and flock protection measures including potential costs as well as to obtain the necessary support during change processes in alpine farming systems. On the other hand, it is important that such an advisory centre is already in existence when attacks on livestock become more common and the need for urgent consultation arises. As such an advisory centre would have potential to influence the behaviour of affected players, a participative approach and high degree of social competence are crucial attributes for consultants besides technical competence in farming systems and flock protection. The advisory centre should help people to rethink their individual situation and support their change processes. This can include, for example, developing a technical solution to protect their flock or, according to the situation, discussing alternative strategies to address the challenge of large predators e.g. temporary or permanent avoidance of encounters with large predators, change

of the individual farm structure and farming system, termination of the farm.

To compensate additional costs due to the increasing presence of large predators, provision of subsidies should be considered. Financial support of alpine farmers would be most important, as they are the players most directly affected by the upcoming change processes. Subsidies could be paid for adaptations in alpine farming systems and flock protection measures. In Switzerland for example, alpine sheep farming systems are classified in three different categories – free grazing, rotational grazing (prescribed grazing) and continuous shepherding (controlled grazing) – and receive subsidies accordingly, corresponding to sustainability in terms of natural resources and protectability of grazing animals (BLW, 2016). Further subsidies could be granted for the implementation and continuation of various flock protection measures. These financial incentives reduce insecurity and foster willingness to initiate change processes.

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References

AB (Amt für Bergwirtschaft) (2011) Datenerhebung almwirtschaft in Südtirol im jahr 2011 (Data collection of alpine farming in South Tyrol in the year 2011). Unveröffentlichte Arbeitstabelle, Bozen.

AF (Abteilung Forstwirtschaft) (2016a) Wild, jagd (Wildlife, hunting). Available: www.provinz.bz.it/forst/wild-jagd/wild-jagd.asp

AF (Abteilung Forstwirtschaft) (2016b) Südtirols almen in zahlen (Alpine farms of South Tyrol in numbers). Available: www.provinz.bz.it/forst/wald-holz-almen/almen-zahlen.asp

AGRIDEA (2016a) Jahresbericht herdenschutz Schweiz 2015 (Annual report. Flock protection in Switzerland 2015). Available: www.protectiondestroupeaux.ch/fileadmin/doc/Berichte/Jahresberichte/Agridea/Version_Online_Rapport_2015_v1_DE_def.pdf

AGRIDEA (2016b) Herdenschutz Slowenien (Flock protection in Slovenia). Available: www.protectiondestroupeaux.ch/international/slowenien/

AGRIDEA (2016c) Herdenschutz Italien (Flock protection in Italy). Available: www.protectiondestroupeaux.ch/international/italien/

BLW (Bundesamt für Landwirtschaft) (2016) Weisungen und erläuterungen 2016. Verordnung über die direktzahlungen an die landwirtschaft (Direktzahlungsverordnung, DZV; SR 910.13) vom 23. Oktober 2013. (Instructions and explanations 2016. Regulation of the direct payments for agriculture). Bundesamt für Landwirtschaft BLW, Bern.

FU (Forststationen im Untersuchungsgebiet) (2014) Kontrollblätter der alpung 2014. (Checklists of alpine farming 2014). Südtirol.

Mettler D, Werder C, Müller M (2014) Schafalpplanung Kanton Wallis 2012-14 (Planning of sheep alpine faming, Canton Valais 2012-14), Schlussbericht, AGRIDEA.

Moser S, Werder C, Mettler D (2016) Kleinviehalpung im westlichen Südtirol – Akteure, Bewirtschaftung und Herdenschutz. Analyse der Akteure und Strukturen; Empfehlungen für Kleinviehhalter, Bewirtschafter und Eigentümer; Empfehlungen für das Land Südtirol. (Small livestock husbandry in western South Tyrol – players, management and flock protection. Analysis of players and structures; recommendations for owners of small livestock, alpine farmers and owners of alpine farms; recommendations for the province of South Tyrol).

TDM (Tierärztlicher Dienst Meran) (2016) Statistik der aktuellen tierbestände und betriebszahlen (Statistics of current animal stocks and farm data). Stand Februar 2016.

Werder C., Bamert C. (2015) Schafalpplanung Uri 2014/2015. (Planning of sheep alpine faming Uri 2014/2015) Schlussbericht, Büro Alpe, 1-32.

Typical landscape of Valais in the region of Zermatt. Photo: Agridea.

Research Article

FROM FREE GRAZING TO FLOCK MANAGEMENT: A CASE STUDY FROM SWITZERLAND

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1. Introduction

In a world of constant evolution, changes in agricultural practice are influenced by various factors. Environmental, socio-economic and psychological aspects all play a role. In regions where eradicated predators are now returning thanks to more stringent protection provisions, livestock owners are once more faced with change processes[1]. Shaping and guiding such processes represents a challenging task for administrators and advisory service providers. This task is subject to political decisions, and decision-makers may adopt either a sceptical or a positive approach. The canton of Valais in Switzerland provides an example of how wolf management and agricultural policy can impact practices in the area of small livestock farming as part of such long-term processes. It also demonstrates the relationships between various factors which can influence change processes.

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[1] In an agricultural context, the term "change processes" refers to the evolution of agricultural practice influenced by a complex setting of various economic, environmental and social aspects.

2. The impact of the wolf on sheep farming

Individual wolves have dispersed to Valais from France and northern Italy since 1995. They first arrived in French-speaking Lower Valais (Fig. 1), but later also spread to the German-speaking eastern region of the canton.

During the period from 2003 to 2012, the number of wolves was within the range from 3 to 12 individuals. Since the establishment of the first wolf pack in 2012, however, the number increased rapidly (Fig. 2) (KORA, 2016).

The traditional system of free grazing on Alpine meadows in summer with livestock checked at least once a week is an important part of the grazing and production cycle in Valais. This system of low control, which had been practiced for decades, was suddenly confronted with the "wolf factor". Before the wolf returned, sheep numbers had increased in Switzerland and by the mid-1990s exceeded 400,000: a level that had not been seen since the 19th century. Agricultural policy as well as the process of industrialisation, which made it economically possible to continue sheep farming as a side-line enterprise, had contributed to this development. However, it soon became clear that this system of grazing was not compatible with the presence of large carnivores. The following key questions have thus been posed from the moment the wolf returned to Switzerland: How can sheep farmers adapt to the new situation and are they willing to do so?

Fig. 1. Cantons of Switzerland. The designation of the lower cantons, where wolves have arrived and established, is as follows: BE – Bern, FR – Fribourg, GR – Graubünden, LU – Luzern, TI – Tessin, VD – Vaud, VS – Valais. (Source: BFS - Federal Office of Statistics).

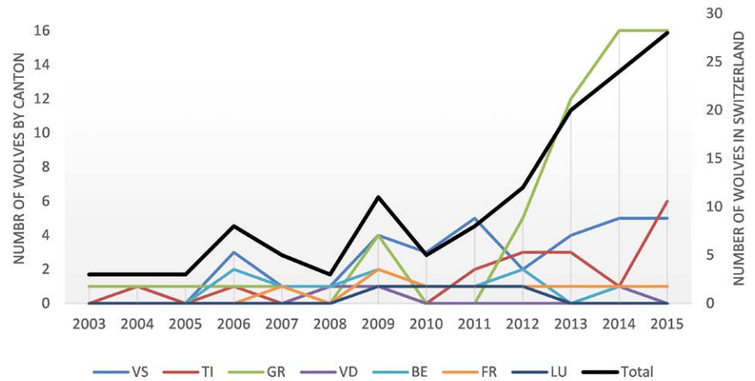

Fig. 2. The number of wolves in Switzerland between 2003 and 2015. Each canton is represented by a different colour and the total number of wolves in Switzerland is shown in black (VS – Valais, TI – Tessin, GR – Graubünden, VD – Vaud, BE – Bern, FR – Fribourg, LU – Luzern) (Source: KORA, 2016).

This article outlines four key factors that have had an impact on change processes in Alpine sheep meadow management since the return of the wolf to the canton of Valais and shows how these changes can be positively influenced and guided. A comparison is then made between national and regional developments in the canton of Valais between 2003 and 2015.

3. Factors affecting change processes

3.1. Psychological: dealing with risk and uncertainty

All operational changes are underpinned by decisions that are triggered by several motivating factors. The presence of the wolf, the experience of having wolf attacks and the perceived risk of losing livestock provide the impetus both for taking short-term preventive measures and implementing long-term changes in farming practices. Economic, cultural and environmental factors play different roles in the case of full-time livestock farmers versus small livestock farmers operating their businesses as a side-line enterprise. This leads to different strategies that may include giving up the business completely, expanding and professionalising the enterprise, changing the livestock kept, adjusting the division of labour or adopting different production methods. The willingness to respond flexibly to a new threat or challenge is decisive. The exchange of advice, provision of support and transfer of knowledge between scientists, administrators and those working on the ground are also important for shaping sustainable changes (Tanner, 2006).

3.2. Socio-economic: structural changes in agriculture

Continuous structural change has affected farm size as well as the economic, environmental and symbolic significance of sheep farming in family businesses for the last 20 years. In addition, the agricultural sector is undergoing a generation change, with a slow shift in values influencing underlying motivating factors and attitudes towards agriculture and nature. These phenomena affect both large, full-time enterprises and small-scale operations. The economisation of everyday farming activities, different demands from consumers and tourists, increased levels of mobility and the intensive use of rural areas by an increasingly urbanised society have changed how farms operate on a daily basis. The importance of landscape conservation and the cultural value of local breeding traditions have also increased relative to the significance given to agricultural production. Symbolic, cultural and identity-forming factors thus remain important even though it is becoming increasingly difficult to maintain work-intensive small livestock farming activities with the younger generation. A long-term trend can be observed in sheep farming: the number of small farms is in decline, while the number of large enterprises is slightly increasing thanks to agricultural policies that aim to support more efficient and professional production.

3.3. Environmental: biodiversity and grazing management

As a result of structural changes in agriculture, there has been an increase in woodland cover in areas no longer farmed. In southern Alpine regions, in particular, there has thus been an expansion of habitats suitable for wildlife. The level of vegetation encroachment has increased at lower and medium altitudes, whereas above the tree line sheep flocks have become more concentrated during summer months. In Switzerland in the 1990s, sensitive vegetation zones in high mountains were subject to local overgrazing due to a lack of herd management. This triggered a debate about the environmental significance of sheep grazing on alpine pastures. At the same time, a gradual 'greening' of the agricultural sector also saw an increase in the significance of aspects relating to biodiversity.

It was for these reasons that a new Ordinance on Summer Pasturing Subsidies was introduced in 2000, which differentiates between three grazing systems: 1) free grazing[2]; 2) rotational grazing[3]; and 3) permanent shepherding[4]. These three systems are now supported with different levels of subsidy with the objective of promoting rotational grazing and permanent shepherding in order to improve the quality of sheep production and biodiversity. When the Ordinance was introduced, the financial incentives were 100, 250 and 350 Euros per livestock unit (LU) put to summer pas-

[2] No flock management and at least one check of sheep flock once a week.
[3] Sectoral grazing with fences or natural barriers and pasture change every two weeks.
[4] Management by shepherd with controlled grazing and overnight places.

ture, respectively. Within the framework of the new agricultural policy for 2014-2017, the amounts for controlled grazing have been increased to CHF 320 (350 euros) for rotational grazing and CHF 400 (440 euros) for shepherded and protected Alpine pastures.

3.4. Political: wolf management and flock protection

For several years, agricultural policy prevented changes towards the liberalisation and greening of the agricultural sector. Against the backdrop of this rather conservative context, a cautious wolf policy emerged that, in adopting both a pragmatic and sceptical stance towards the return of the wolf, has shaped the framework for the management of wolves and protection of flocks. Thanks to legislation on compensation payments, flock protection and wolf regulation, financial support for livestock farmers has been secured over the long term. While this means that changes can be implemented on a sustainable basis, it will nevertheless not be enough if other factors do not have a positive impact on developments.

Where change processes are perceived to represent progress, even conservative rural areas have shown themselves willing to actively push forward with changes. However, if changes are viewed as a backwards step, and this is often the case in connection with the return of the wolf, very little willingness is shown at the beginning of the process in terms of adopting behavioural changes. In rural areas, a negative attitude towards economic pressure and additional work is linked to the general tendency in agriculture to increase farm size and profitability (Mack and Flury, 2014). Within this context, resistance to changes can develop at any time.

Despite such inhibiting factors, a gradual change has been observed over the past 15 years. This has been strongly shaped by financial incentives as part of national policy as well as changes at an operational level such as generation changes or new owners.

4. Participatory management: Alpine sheep meadow planning in Valais

In 2012, the canton of Valais and the Federal Office for the Environment commissioned an analysis of sheep summering in the Valais region. The objective was to clarify questions relating to management and protection of flocks within the framework of a comprehensive Alpine sheep meadow plan. A conscious decision was taken to select a participatory approach in order to incorporate the key players in the area of Alpine farming. This mandate was performed between 2012 and 2014 by Agridea – Swiss Association for the Development of Agriculture and Rural Areas, supported by a steering committee comprising representatives from the spheres of agriculture, wildlife management and forestry. The adopted approach was viewed as pioneering in Switzerland and has helped the canton to implement longer-term flock protection measures. The exemplary character of this project also illustrates how the aforementioned factors can impact individual behavioural changes and collective processes.

In applying a participatory approach, the objective was to work together with Alpine farmers and shepherds to establish the basis for optimising farming activities and conditions for flock protection. This included recording the grazing perimeters, drawing up a rough grazing plan, calculating the forage yield, documenting existing infrastructure and identifying ownership and herd structures (Fig. 3). The results, summarized below, should serve to help make structural improvements and create the framework for facilitating flock protection measures and optimizing grassland management. Responsibility for the implementation of the recommendations lies with the cantonal Department for Agriculture, which together with the regional advisory services will work with farmers to flesh out the recommended measures and implement these over the coming years (Mettler et al., 2014).

4.1. Summered sheep

Half the 50,000 sheep summered in Valais graze freely (continuous grazing), while 14% graze on a rotational basis and 37% are shepherded on Alpine meadows. The vast majority of the 155 Alpine meadows provide summer pasture for between 150 and 450 animals. On 35 Alpine meadows (23%), the number of animals exceeds 450. This is the minimal size to hire a shepherd with an appropriate salary. Most Alpine meadows are owned by public communities or alliances (cooperatives in Upper Valais). Almost one third of Alpine meadows are farmed by a single farmer, with a further third utilised by more than five. In Upper Valais, primarily white Alpine and Black Nose sheep

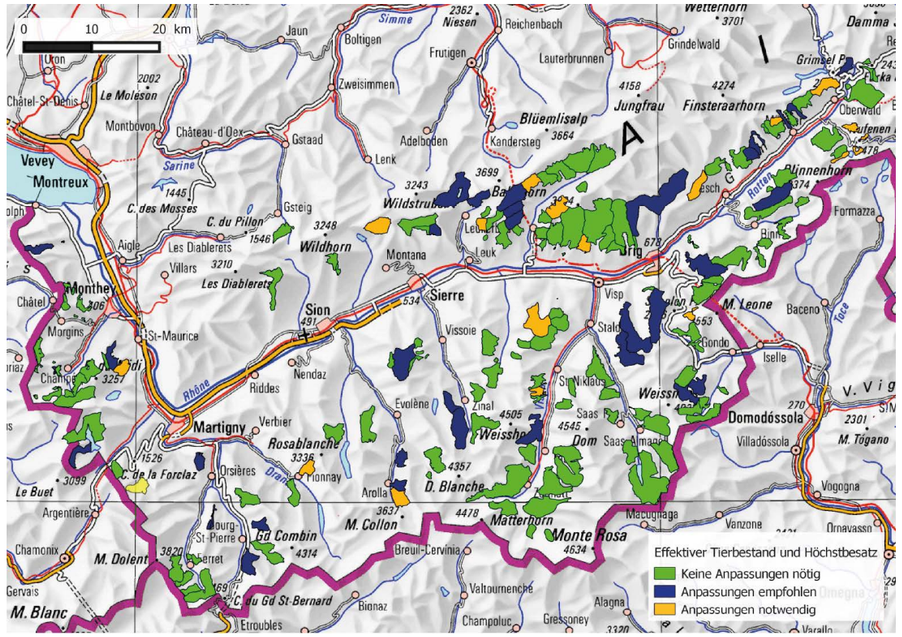

Fig. 3. Alpine sheep meadow plan (Source: Agridea). Alpine perimeters have been defined and classified in three different categories of flock management (green – no change of herd size recommended; blue – change of herd size and management recommended; orange – obligation for change of herd size and management).

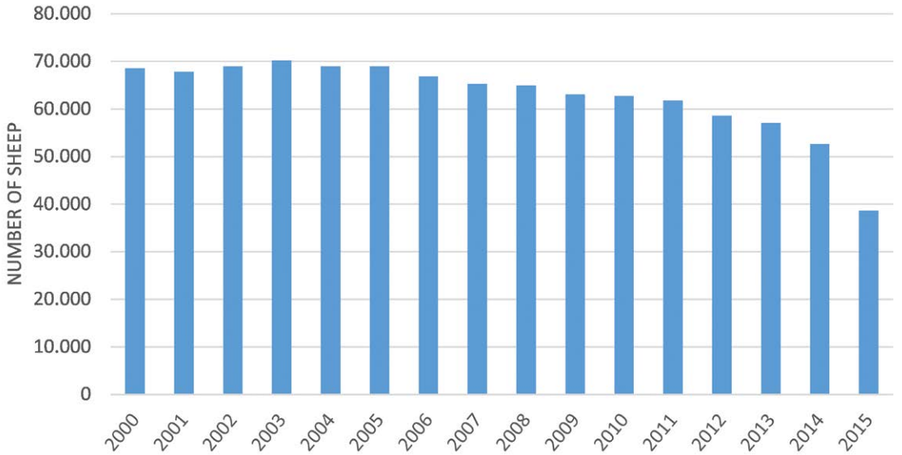

Fig. 4. The total number of sheep kept in the canton of Valais between 2000 and 2015. The decrease between 2014 and 2015 is partly due to changing the date of data collection from June to January (Source: Swiss Federal Office of Statistics).

are put to summer pasture, while in Lower Valais there are predominantly white Alpine sheep and a variety of fattening stock. The summer grazing period lasts between 70 and 150 days. Despite regional differences, the number of animals put to summer pasture has been on the decline for several years (Fig. 4).

4.2. Cultural differences

Sheep farming in Valais is characterised by cultural differences which manifest themselves along the language frontier between the French and German-speaking regions. There are significant differences in terms of sheep breeds and husbandry systems. This is reflected in the infrastructure and tradition of shepherding as well as in the breeding criteria. While in Upper Valais high socio-cultural and environmental significance is attached to the farming of Black Nose sheep, in Lower Valais greater importance is assigned to economic criteria when rearing sheep. Although this cultural divide is evident in the areas of agriculture and livestock farming, the wolf debate represents a common denominator.

Since the rise of industrialisation in Upper Valais,

Black Nose sheep, typical breed of Valais.
Photo: Agridea.

traditional subsistence farming has been replaced by the "working farmer" approach, leading to a change in the importance of agriculture. A living income is now guaranteed by jobs in the industrial sector, while work in agricultural enterprises has more socio-cultural significance. Breeding criteria relating to an animal's outward appearance became more important than considerations of productivity. Traditional sheep markets and shepherd events have thus increased in significance. These traditions are unique in Switzerland in terms of their form and the frequency with which they occur. Within this seasonal rhythm, the work of shepherds is thus geared towards the traditional sheep market, which usually takes place during autumn. At this time, a village and its surrounding region come together to celebrate at a livestock show and subsequent convivial gathering. It is for this reason that the Black Nose sheep is one of the most important symbols of the Upper Valais identity. The enormous effort put into breeding these animals is driven by competition as well as social prestige.

In Lower Valais, even larger farms (more than 150 ewes) can be found at which lamb meat production still represents an important source of income. In some cases shepherds are employed, while in others the flock owners themselves go to the Alpine pastures. The summer grazing period tends to be longer as meadows are at lower elevations. Lower-lying Alpine pastures are used more intensively and have relatively good access. Alpine lodgings can be found at most locations. Sheep farming is less tied to the major industrial enterprises than in Upper Valais. Furthermore, sheep farming only plays a marginal role in the agricultural sector, as viticulture and fruit growing assume a more important position due to the topographical and climatic conditions. Sheep farming is more greatly shaped by French culture and thus is also strongly oriented towards France, in regard to both shepherd culture and the value chain of sheep products.

4.3. Differences between valley communities

The regions also differ greatly in terms of their grazing systems and stocking densities. For this reason, 19 different valley communities are distinguished in the Alpine sheep meadow plan. In some cases, sheep play virtually no role, while in others they are the dominant livestock species. The significance of sheep is also dependent on the role played by large livestock. While the mixed use of different species is still practiced in some areas, in others dairy cattle have almost disappeared. Regional differences provide the context for adapting the Alpine sheep pastures plan to local requirements and regional events. This also includes taking account of Alpine cattle meadows that are no longer used or have a low stocking density. Tourism also differs considerably between the regions, as the canton contains both unknown, poorly accessible valleys, as well as world famous destinations such as Zermatt and the Aletsch Arena.

4.4. From continuous grazing to shepherding

The extraordinary topographical and climatic conditions of Valais provide a suitable environment for extensive farming with sheep. In order to have a positive impact on the landscape and biodiversity, however, systematic grazing management is required. This needs to take account of both sensitive areas at high altitudes as well as areas at medium altitudes situated close to the shrub and tree line and subject to gradual encroachment. Recommendations from the investigation thus aim to ensure grazing management that incorporates

rotational grazing or shepherding, thus allowing for optimal use of vegetation. For one third of the Alpine pastures adjustments are recommended to prevent overuse or under-use at a local level. For the remaining two thirds, there is currently no need to change stocking densities because the environmental framework is respected by current grazing practices and grazing areas are used in a sustainable manner. With improved grazing management, additional livestock could be put out to pasture on many Alpine meadows. Due to falling animal numbers and increasing pressure from scrub encroachment, it is worthwhile to carefully assess the prioritisation of areas earmarked for continued use.

4.5. Conditions for flock protection

Requirements for working with livestock guarding dogs (LGDs) are met on 15% of Alpine pastures. In around 60% of cases, changes are recommended that are deemed to be both necessary and feasible, while for the remaining quarter of Alpine meadows measures required for flock protection would involve a disproportionate amount of effort. There are major differences between Upper and Lower Valais. In the latter, the basic conditions of flock management such as shepherds, dogs and fences are already in place on around one third of Alpine meadows. In Upper Valais, on the other hand, this figure stands at just 10%. When one considers the size and grazing potential of Alpine meadows, it can be said that all sheep currently put to summer pasture could be summered on protectable pastures. This would mean, however, that those areas that are difficult to protect with LGDs and shepherds need to be abandoned.

In order to lay the foundations for the use of LGDs, the grazing system in Upper Valais would first and foremost have to be changed and the infrastructure for shepherds would need to be improved (see below). In Lower Valais, the use of LGDs should be implemented in a manner that is as conflict-free as possible. Due to very intensive tourism in some areas, the potential for conflict and objections from the tourism sector about the use of LGDs represents the biggest challenge. It is essential that this issue is clarified in a targeted manner and that advisory services are provided. For both flock protection and management of meadows, flocks in areas of difficult topographical terrain should not be too large (600-800 animals). In order to optimise both these factors, it appears that a mix of shepherding and rotational grazing often represents the best solution.

Night corral under Alpine conditions (Canton Graubünden).

4.6. Shepherding

In order to allow for sheep summering to play a positive role in landscape conservation, biodiversity and animal welfare as well as in the production of high quality products, the appointment of expert shepherds is key. For this to be possible, the necessary framework needs to be in place. This includes the provision of training opportunities as well as proper accommodation, wages and appreciation of this work. The shepherd training scheme in Visp, which was introduced four years ago, as well as a French training programme in Châteauneuf, which has been offered since 2013, should contribute to ensuring a high quality of work. Nevertheless, accommodation for shepherds is often lacking, particularly in Upper Valais, and is inadequate or poorly located in Lower Valais. Despite the summering contributions, wages are in many areas insufficient to provide appropriate compensation for the work and to prevent a high level of fluctuation. There is also the fact that the seasonal nature of the appointments represents a difficult hurdle on the labour market. The policy adopted by the Confederation is attempting to create improved incentives by providing greater financial support for summering.

4.7. Vegetation encroachment

The expansion of forested areas as well as dwarf shrub[5] and scrub areas in locations at medium altitudes of between 1,600 and 2,200 metres above sea level is a widespread phenomenon. There are, however, major regional differences. The canton of Valais is more greatly affected as a result of the decline in the number of livestock on summer pastures and its difficult topographical terrain. Inspections have clearly shown that many areas located in the lower parts of Alpine sheep pastures and former Alpine cattle pastures are greatly underused. In some cases, plant succession is now at such an advanced stage that large areas of potential grazing have already been lost. As grazing areas on most Alpine sheep meadows are located above the tree line, they are mostly found at the vegetation level inhabited by dwarf shrub communities, which can in some cases be encountered at altitudes of up to 3,000 m.

As underuse is observed in the majority of Alpine sheep meadows, the impact that sheep have on these dwarf shrub areas is limited. Due to their specific eating habits and avoidance of woody species the sheep, with the exception of a few breeds, are able to make little impact where succession is at an advanced stage. Only with the intensification of meadow management through systematic fencing or the consistent use of permanent shepherding is it possible to stop or purposefully influence scrub encroachment processes (Chatelain and Troxler, 2005).

Even if the landscape conservation role played by sheep is rather marginal above the tree line, in the canton of Valais sheep remain an important factor in maintaining areas in lowland regions and at medium altitudes up to the tree line. The use of spring and autumn meadows for fodder and the mowing of high-yielding areas for stable feed means that Valais sheep farming plays a key role in the use and preservation of areas subject to significant scrub encroachment.

4.8. Implementing the Alpine sheep meadow plan

The recommendations for farming and flock protection as well the grazing plan should support the cantonal advisory services in implementing the Alpine sheep meadow plan on a sustainable basis. Based on the national and cantonal consulting network, it will be seen how quickly suitable measures can be implemented in order to make the required structural adjustments to allow for the use of shepherds and livestock guarding dogs. By adopting a regional approach, the objective is to implement the plan on a step-by-step basis over the next three to six years. If the trend towards declining livestock numbers further increases, it will not be possible to manage all the areas currently used on a sustainable basis. For this reason, early planning could identify prospects for continuing to shape sheep summering in a sustainable manner through the use of suitable investments and forms of cooperation. This will require appropriate policy decisions as well as the resources of farmers, who are confronted with the challenges of generational change and economic uncertainty. It is to be hoped that the living and deep-rooted tradition of sheep farming in Valais can meet these upcoming challenges and that the changes underway can be actively shaped by sheep and Alpine meadow owners (Werder and Bamert, 2015).

[5] Species such as *Rhododendron ferrugineum* L, *Ericacea*, *Junniperus communis*.

5. National incentives and regional differences

When looking at the development of grazing systems in the canton of Valais between 2003 and 2015 (Fig. 5), it is striking that the trend towards shepherding first intensified during the phase of participatory planning. A national comparison shows that these changes started in other regions as early as 2003 (Fig. 6) even though the presence of wolves was less pronounced or non-existent there. It is to be assumed that financial incentives had a decisive impact on these changes. Nevertheless, in both cases it can be seen that the trend towards shepherding has increased since 2011. Furthermore, a decreasing trend in livestock numbers can be observed at both national and regional levels. It is therefore apparent that the change in grazing systems has primarily taken place thanks to financial incentives, with the wolf playing only a secondary role.

When looking at trends in the use of LGDs, a stagnation can be observed in the canton of Valais (Fig. 7). In the other cantons, however, the number of LGDs has developed in line with the presence of wolves or the probability of wolf attacks. This important difference can be explained by the fact that damage prevention measures have become a highly politicised issue. The use of LGDs is viewed as an acceptance of the wolf's presence, whereas the latter is still being contested by most agricultural associations (Werder and Bamert, 2015). In contrast to the changes related to grazing practices, the use of LGDs can primarily be attributed directly to permanent wolf presence. In cantons where wolf numbers have not increased, the use of LGDs has declined. Nevertheless, it must be noted that the lynx is also playing a role in developments, albeit only in the pre-Alpine cantons of Vaud, Bern and Fribourg.

6. Summary and conclusions for flock management and flock protection

The return of the wolf has added new momentum to national policy, which together with other factors has resulted in changes in the farming of small livestock. National incentives for changes in flock management can improve the resilience of sheep farming in the face of wolf presence. During the last 15 years the national flock protection strategy has had the following key impacts:

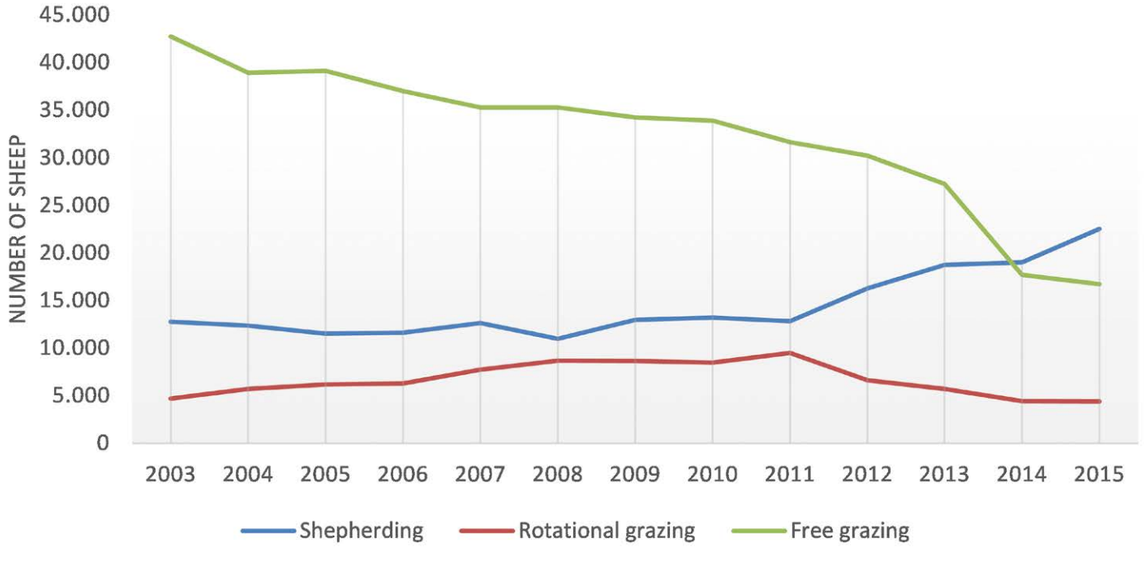

Fig. 5. Prevalence of three flock management systems from 2003 to 2015 in the Canton of Valais (Source: FOAG).

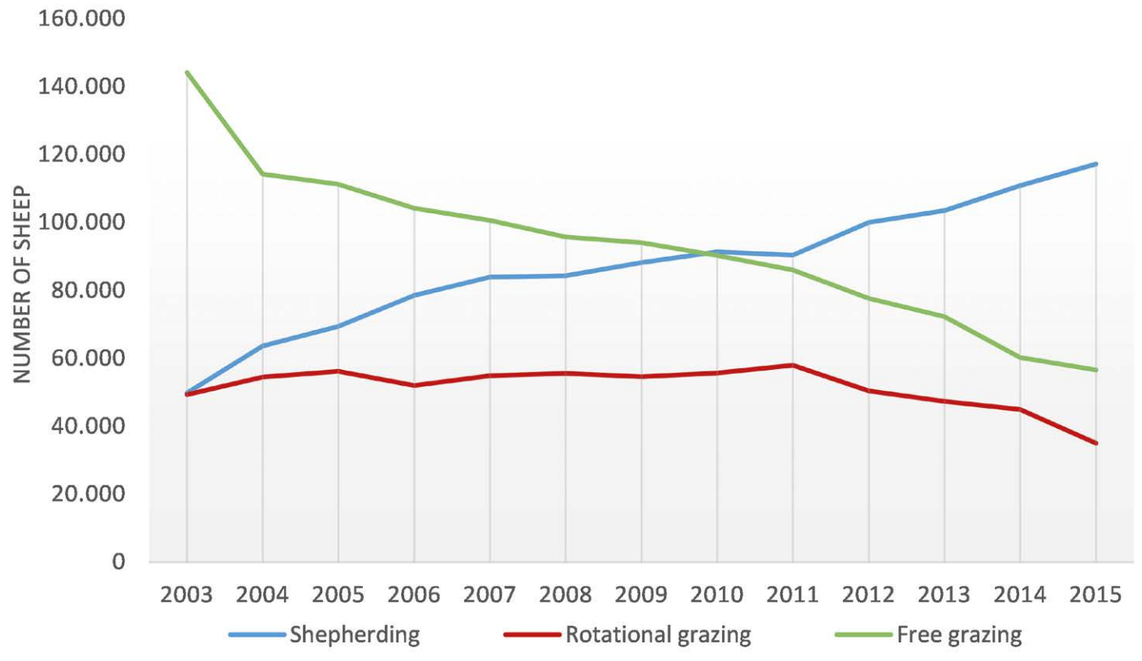

Fig. 6. Prevalence of different flock management systems in Switzerland from 2003 to 2015 (Source: FOAG).

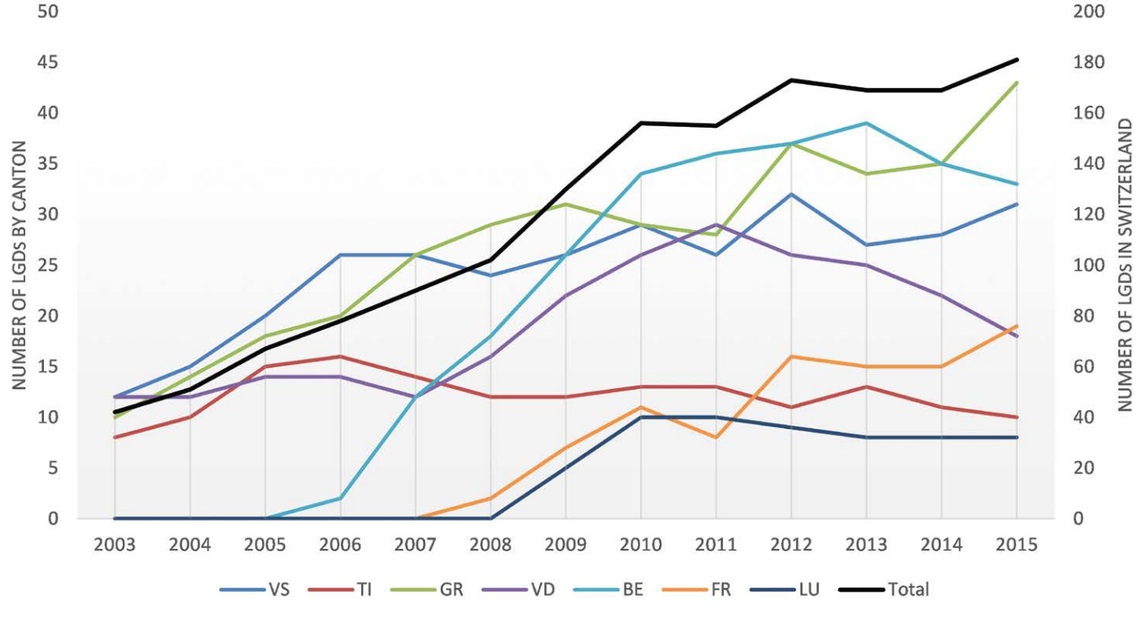

Fig. 7. The number of livestock guarding dogs (LGDs) in cantons of Switzerland with wolf presence from 2003 to 2015 (VS – Valais, TI – Tessin, GR – Graubünden, VD – Vaud, BE – Bern, FR – Fribourg, LU – Luzern). The total number of LGDs in Switzerland is shown by the black line (right axis).

1. The Ordinance on Summer Pasturing Subsidies, with differing incentives for the three grazing systems, drove a change from free grazing practice to shepherding and flock-management (from 2000);
2. Increased use of livestock guarding dogs in summer pasture holdings with shepherding (from 1999), in fenced valley meadows (from 2002) and in summer pasture holdings with small flocks without shepherds (from 2005);
3. Structural changes through the amalgamation of flocks (from 2006);
4. Development of a flock protection advisory system by the Ministry of the Environment (from 2006);
5. Establishment of a legal framework for working dogs in the agricultural sector (from 2008);
6. Development of a flock protection advisory system by the Canton (from 2009);
7. Legislation on flock protection in the national Hunting Ordinance (from 2013);
8. Increased use of electric fences for flock protection in valley meadows (from 2013).

The specific trigger for initial changes to flock management was usually wolf attacks, which were immediately followed by emergency measures such as spotlights, shepherd assistance or emergency LGDs. Changes to farming operations were then made in the following year. Public funds for flock protection measures and the direct payment system in the agricultural sector generated financial incentives relatively quickly in order to establish these measures over the longer term. Further institutional and legal changes were made after a few years. An advisory network developed in parallel to these developments, with the systematic training of dog breeders and shepherds. Regions without wolf presence were able to benefit from experience in areas that suffered wolf damage, anticipating certain developments and initiating learning processes in advance.

The impact of wolf numbers on changing practices in pastoralism has not been systematically analysed. However, comparing the trend in the use of LGDs (Fig. 7) with that of wolf numbers (Fig. 2), it seems likely that the increasing number of LGDs in some cantons is directly related to the presence of wolves. In contrast, Valais is the only canton where a change from free grazing to flock management seems to be in direct relation with wolf presence. In the other cantons, changes in pastoralism were mainly influenced by the subsidies policy with the aim of improving mountain pastures.

A survey of small livestock farmers could prove informative in identifying key motives and factors behind shifts in grazing practices. The wolf is very often named as the decisive factor behind such changes. It seems evident that flock management depends largely on the availability of subsidies (Lauber et al., 2014) whereas the use of LGDs is more directly linked to the number of wolves in the region. However, this is not confirmed by data from Valais. This could be linked to the fact that there are many other issues which can play just as big a role in influencing farming decisions as the probability of damage caused by wolves.

The results from the Valais Alpine sheep meadow plan and changes in flock protection seen to date have shown that continuity in the provision of advisory services and the establishment of a planning basis provide a trust-building springboard for finding and implementing individual and collective strategies for dealing with a phenomenon such as the return of the wolf. In its role as a stimulus for change processes, however, the wolf remains a conflict-generating, political and tension-fraught flagship issue in connection with the future of shepherds and sheep flocks.

References

Chatelain C, Troxler J (2005) Gardiennage permanent des moutons à haute altitude. Revue Suisse Agricole, 37, 151-160.

Lauber S, Herzog F, Seidl I, Boni R, Burgi M, Gmur P, Hofer G, Mann S, Raaflaub M, Schick M, Schneider M, Wunderli R (2014) Zukunft der schweizer alpwirtschaft. Fakten, analysen und denkanstösse aus dem forschungsprogramm AlpFUTUR. Birmensdorf, Eidg. Forschungsanstalt WSL, 198 p.

Mack G, Flury C (2014) Wie wirken die neuen Alpungsbeiträge? Agrarforschung Schweiz, 88-95. Agroscope.

Mettler D, Werder C, Müller M (2014) Schafalpplanung Kanton Wallis 2012-14, Schlussbericht, Agridea.

Tanner C (2006) L'Agora du Loup, Analyse de la controverse sur l'arrivé du loup en Suisse, Lausanne.

Troxler J, Chatelin C (2005) Gardiennage des moutons en haute altitude, Agroscope RAC.

Werder C, Bamert C (2015) Schafalpplanung Uri 2014/2015. Schlussbericht, Büro Alpe.

Further information

National network for LGDs and protection of flocks: Agridea: **www.herdenschutzschweiz.ch**
Monitoring and management of large carnivores: **www.kora.ch**
Subsidies for summer grazing, Federal Office of Agriculture: **www.blw.ch**
Legal framework for protection of flocks, Federal Office of Environment: **www.bafu.ch**
Swiss Federal Office of Statistics: **www.bfs.ch**

THE GRASS IS GREENER

ON PREDATOR FRIENDLY FARMS

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Dairy cows with a guardian dog on a predator friendly dairy, Burruduc Farm, Australia. Photo: Elena Swegen.

For the past decade I have been researching the ecological role of Australia's top predator - the dingo. Travelling countless miles, I had failed to find a place where dingoes are free from poisons, traps and guns. Even national parks provide no safe haven, as they are regularly poison baited against foxes and dingoes. And so, with the support of a Churchill Fellowship I set out to find places around the world where predators were left in peace.

Large predators are vital for the health of ecosystems. Biodiversity is richer in their presence because they limit herbivore prey animals and smaller predators. They are also some of the most persecuted and endangered animals, which has had devastating effects on other species and entire ecosystems (Ripple et al., 2014). In Australia, persecution of dingoes has caused a wave of mammalian extinctions, due to population irruptions of smaller predators (Wallach et al., 2010). In contrast, the reintroduction of wolves to Yellowstone National Park has triggered dramatic recovery of vegetation and animal communities, through their predation pressure on elk and other prey. Trees that had been unable to regenerate for decades are now thriving where wolves are returning. Even the courses of Yellowstone's rivers have been changed by this 'trophic cascade' (Beschta and Ripple, 2012).

Yellowstone National Park was therefore first on my list as a prime location to find out what a safe place for predators actually looks like. The reintroduction of wolves into the park in 1995, seventy years after extirpation, sparked a revolution in our understanding of ecology and inspired a new vision of our relationship with nature. Indeed, during the first few years, wolves received legal protection both in and out of the park. But I had arrived too late to see it.

By 2012 wolves lost much of their brief protection under the Endangered Species Act, and wolf hunting began outside the park in several states. Yellowstone National Park became a small island of safety, with no way for the wolves to recognise the boundaries. Inside the safety of the national park the wolves had regularly encountered people who eagerly watched them through scopes, but outside they suddenly came across people waiting with guns. It became clear that national parks and other protected areas cannot on their own provide the solution.

Predator Friendly Farming

The livestock industry has been leading the 'war' on predators for generations, driving them out of vast rangeland regions, even eradicating them from entire countries. Australia built the world's longest fence (over

Dingoes are persecuted across Australia, primarily with poison baiting (left panel), and they are also shot, displayed, and scalped for bounties (right panel). Boulia, Queensland. Photos: Arian Wallach.

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Jackals and vultures gather at a feeding station in a predator friendly game reserve outside Pretoria, South Africa. Photo: Arian Wallach.

5,500 km long) just in order to eradicate dingoes from sheep-grazing regions. It is still common practice for government departments to offer bounties on dingoes, and to fund poison-baiting campaigns, even inside national parks. It is not unusual to find dead dingoes hanging from trees and posts across the Outback.

But a new kind of cowboy is quietly leading a revolution in humanity's relationship with the natural world (Johnson and Wallach, 2016). They are raising sheep, goats and cattle, even chickens, in environments shared by lions, tigers and bears, and providing safe havens for predators where none were found before. 'Predator friendly' farmers are demonstrating that killing predators for livestock production may be a dying practice.

Studies of livestock protection methods around the world are finding that nonlethal management is not only far more ethically and environmentally sound, it is also good for business. A 3-year study across the Eastern Cape Province, South Africa, showed that farmers were economically better off when they stopped killing leopards (McManus et al., 2015). Eleven participating farms were monitored during their transition from killing predators, and for two years of predator friendly farming. The farmers used a range of nonlethal methods, including guardian animals and protective collars on their sheep, but the results were consistent. Dr Jeannine McManus, lead author of the study, found a 70% decline in both predation losses and running costs per head on these farms.

Large predators exert strong pressures on each other through social interactions, such as territoriality and restrictions on breeding (Wallach et al., 2015). Killing predators fractures their social structures, which can lead to higher reproduction and immigration, and to higher attack rates on livestock. Studies in Australia, North America, Europe and South Africa, have all similarly found that killing predators can lead to higher predation rates on livestock (Allen, 2013; Wielgus and Peebles, 2014; Treves et al., 2016).

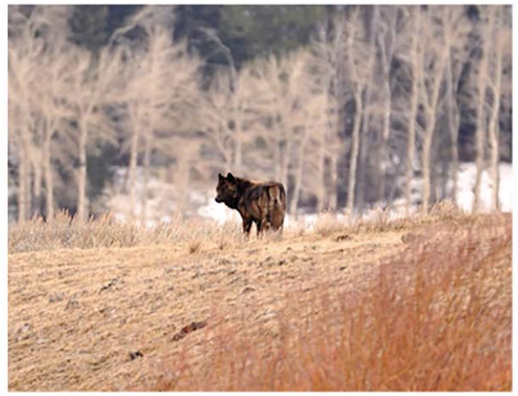
Rob Harrison, award-winning filmmaker and director of the South African based Wildlife Damage Research and Management, has been closely monitoring a protected population of black-backed jackals. South African sheep and game farmers regularly trap, shoot and poison jackals, but Harrison's research is showing that this is a mistake. "When left alone jackals become fiercely territorial", he explains. "If you kill jackals you'll end up with even more jackals and more predation because their social structure breaks down".

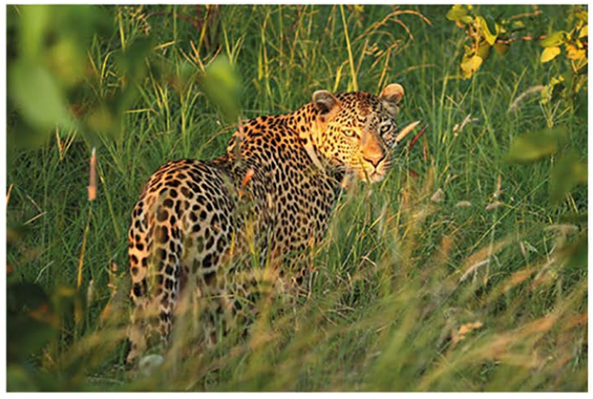
South African farmers that have committed to protecting predators on their land are now gaining an additional advantage, with a Fair Game certification scheme. The Landmark Foundation is successfully working with farmers to promote nonlethal alternatives to protecting livestock from leopards, jackals and caracal. The Foundation collaborates with certified farmers by providing information on the movement of radio-collared leopards in the region, assistance with improving non-lethal techniques, and provision of compensation for stock killed by predators. "The focus must shift from predator control to controlling and guarding your stock," says Dr. Bool Smuts, founder of the NGO. "It is a paradigm shift".

Farming of the Future

One of the earliest predator friendly certification brands originated in Montana, North America, in the 1980s. "Early producers that chose to protect predators received death threats from their neighbours", says Julie Stein, Executive Director of Wildlife Friendly Enterprise Network (WFEN). "Much has changed since then". They provide Predator Friendly® certifications to producers around the globe. Last year, Stella McCartney Inc., led by the daughter of musician Sir Paul McCartney, became the first global fashion brand to commit to sourcing certified materials.

One of the earliest farmers to join the scheme was Becky Weed, owner of Thirteen Mile Wool and Lamb Company near Yellowstone National Park, who is successfully running her family business in an environment shared by wolves, coyotes, bears and cougars. Unlike neighbours who resent the return of wolves, Weed has been a vocal advocate for wolf recovery and has built her farming practice on a commitment to respecting the other creatures that share her land. "We all have to learn to farm as if nature matters," she says. Abigail Breuer, Program Director of WFEN, is noticing the shift in attitudes. "Thanks to the example set by predator friendly farmers, slowly but surely Western ranches are increasingly adopting proactive measures to coexist with large carnivores", she says.





Wolves are protected inside Yellowstone National Park (Photo: Kemble Widmer) and leopards are safe inside Kruger National Park, South Africa (Photo: Craig Jackson), but these areas are not enough. Predator friendly farmlands are providing safe spaces for predators outside protected areas. Certifications, such as Predator Friendly® and Fair Game are acknowledging and rewarding pioneers of 21st Century farming.

Herders walk with their mixed herd of cattle, sheep and goats during the day (left panel), and then enclose them in a protective kraal by night (right panel) in Dimbangombe, Zimbabwe. Photos: Arian Wallach.

All around the world farmers are developing ways to protect their herds without resorting to killing predators. Dimbangombe is a predator friendly ranch in Zimbabwe, run by the African Centre for Holistic Management, founded by Allan Savory. "We are successfully grazing a herd of cattle, sheep and goats in an environment rich with large predators, including lions, cheetahs, leopards, wild dogs and hyenas," Savory explains. Indeed, on my visit to the ranch I find evidence of a thriving abundance of wildlife, including many tracks of large carnivores. "Lions were a major cause of mortality in our herd until we developed a ranching method that works," explains training manager Elias Ncube.

Their 500 head of mixed livestock are kept together in a single herd that is guarded and cared for 24/7 by a team of herders and their trusted dogs. During the day the livestock are grazed across the 3,200 hectare property, moving together like a herd of migrating wildebeest. At night the animals are brought into a protective kraal: thick sheeting that keeps the animals in a tight bundle and shields them from predators. A line of blinking lights surrounding the kraal acts as an additional lion repellent. The human and canine herders get a good night's rest as they camp beside them. The resulting biodiversity and productivity I witnessed on the ranch makes many national parks look like wastelands in comparison.

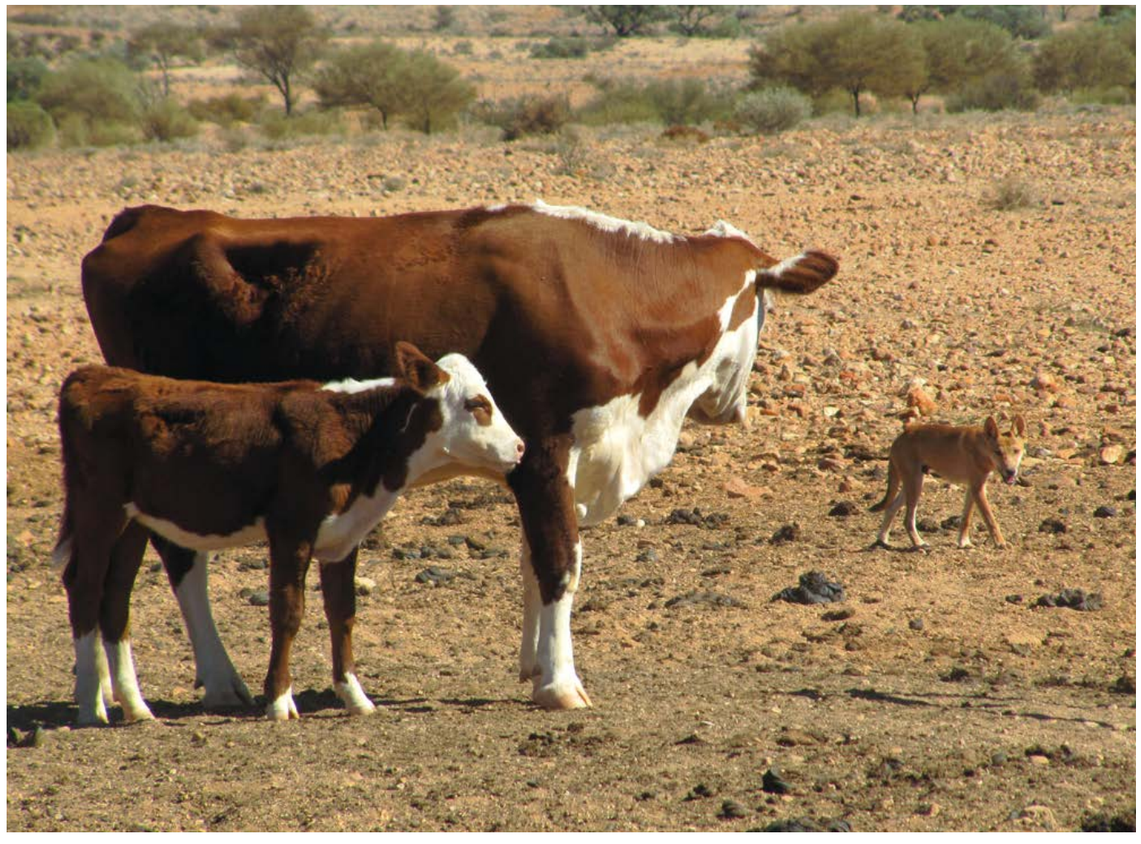
Most livestock producers across Australia poison dingoes and other predators with 1080, a toxic banned in most countries because it is inhumane, kills non-target animals, and is dangerous to humans (Sherley, 2007). This toxic is never used on Burraduc Farm in New South Wales: a predator friendly dairy that employs guardian dogs to protect their herd of cattle and buffalo. "We strongly oppose the use of 1080 poison, having observed the horrific effects on dogs and other animals," says farm owner and Churchill Fellow Elena Swegen. "It is unethical, a wrong approach to the problem and a wrong tool for the task". The offspring of their guardian dogs are now working with livestock across Australia. "Most reports we get on their performances are excellent," she says. Scientists agree.

Livestock guardian dogs have been shown to provide a cost-effective alternative to conventional predator control across Australia. A study of 150 Australian predator friendly livestock producers that used guardian dogs, found that 66% of farmers reported that predation ceased after obtaining guardian dogs, and a further 30% reported a significant decrease of predation (van Bommel and Johnson, 2012).

In many cases even 'doing nothing' provides better outcomes for livestock than killing predators. Evelyn Downs is a 2,300 km^2 predator friendly station in northern South Australia, carrying around 1,200 head of cattle. Contrary to intentions, dingoes were continually getting shot and poisoned. On such large stations, poaching can be a common problem. In 2012 my partner Adam O'Neill and I assumed the management of Evelyn Downs and successfully ensured that dingoes were protected for two years. During our tenure we recorded 56 cattle deaths, most of which were caused by husbandry-related problems, and only eight calf losses were attributed to dingo predation. Six of the dingo-caused deaths occurred during our first 6 months, while the dingoes were still recovering from poaching (Wallach et al., 2017). It was not always easy to restrain the urge to turn to a gun when we caught dingoes feeding on a dead calf. But we found that the best way to 'control' dingoes is to let them sort things out for themselves.

Predator Friendly Network

Growing consumer awareness is enabling – and in some cases forcing – farmers to adapt their practices. Societal values are demanding ever higher ethical and welfare standards in farming practices, both in the



Protecting dingoes did not result in high or increasing predation rates, and most predation subsided after 6 months. Left panel – dingo with cowboy (Photo: Arian Wallach), right panel – dingo with cattle (Photo: Gerrit Schurimann), on Evelyn Downs, a predator friendly station in South Australia.

treatment of livestock and the wild animals that live among them. Predator friendly certifications enable consumers to vote with their money, to ensure that their funds are not fuelling ongoing violence towards wildlife. In a world with a rapidly growing human population, and an increasing appetite for meat, we must find ways to coexist with wildlife outside protected areas.

Predator friendly farming is growing, but it is still a young and fragmented movement. It can be difficult to 'come out of the closet' when everyone around you turns to poisons and guns to solve problems. Many landholders who choose not to kill predators remain isolated and are under intense pressure from neighbours and government to toe the lethal line. Many are also unaware that their management approach is widely supported by the public and by scientists, and that there are many others taking a similar path (Johnson and Wallach, 2016).

The Centre for Compassionate Conservation, University of Technology Sydney, in Australia, is establishing a Predator Friendly Network to provide a platform where progressive farmers can share experiences and support, and to make the certification schemes more accessible. In particular, we aim to enable a friendlier world both for predators and for the farmers that choose to coexist with wildlife. Predator friendly is the farming of the future. It is time to move on.

References

Allen LR (2013) Wild dog control impacts on calf wastage in extensive beef cattle enterprises. Animal Production Science 54, 214-220.

Beschta RL, Ripple WJ (2012) The role of large predators in maintaining riparian plant communities and river morphology. Geomorphology 157, 88-98.

Johnson CN, Wallach AD (2016) The virtuous circle: predator-friendly farming and ecological restoration in Australia. Restoration Ecology 24, 821-826.

McManus JS, Dickman AJ, Gaynor D, Smuts BH, Macdonald DW (2015) Dead or alive? Comparing costs and benefits of lethal and non-lethal human–wildlife conflict mitigation on livestock farms. Oryx 49, 687-695.

Ripple WJ, Estes JA, Beschta RL, Wilmers CC, Ritchie EG, et al. (2014) Status and ecological effects of the world's largest carnivores. Science 343, 1241484.

Sherley M (2007) Is sodium fluoroacetate (1080) a humane poison? Animal Welfare 16, 449-458.

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

van Bommel L, Johnson CN (2012) Good dog! Using livestock guardian dogs to protect livestock from predators in Australia's extensive grazing systems. Wildlife Research 39, 220-229.

Wallach AD, Johnson CN, Ritchie EG, O'Neill AJ (2010) Predator control promotes invasive dominated ecological states. Ecology Letters 13, 1008-1018.

Wallach AD, Izhaki I, Toms JD, Ripple WJ, Shanas U (2015) What is an apex predator? Oikos 124, 1453-1461.

Wallach AD, Ramp D, O'Neill AJ (2017) Causes of cattle mortality on a predator friendly station in central Australia. Journal of Mammalogy 98, 45-52.

Wielgus RB, Peebles KA (2014) Effects of wolf mortality on livestock depredations. PLoS ONE 9, e113505.

Predator friendly links

African Centre for Holistic Management
www.africacentreforholisticmanagement.org

Centre for Compassionate Conservation
www.cfcc-uts.com

Dingo for Biodiversity Project
www.dingobiodiversity.com

Landmark Foundation
www.landmarkfoundation.org.za

Predator Friendly Network
www.facebook.com/groups/1714422825442170

Wildlife Friendly Enterprise Network
wildlifefriendly.org

NEWS

A NEW FUNDING OPPORTUNITY TO SUPPORT CARNIVORE CONSERVATION IN AFRICA

Large carnivores, including charismatic and iconic species such as the lion (*Panthera leo*), cheetah (*Acinonyx jubatus*), wild dog (*Lycaon pictus*) and Ethiopian wolf (*Canis simensis*) are fast disappearing from most of their historic ranges in Africa. With few exceptions, these species are threatened even inside protected areas. Despite conservation action and a few successful reintroductions (e.g. Parc Akagera), the lion remains listed as "globally vulnerable" by the International Union for Conservation of Nature (IUCN) Red List of Threatened Species™ due to declines in most regions across Africa. Only 500 Ethiopian wolves survive, confined to isolated mountain ranges in Ethiopia's highlands and classified as "endangered". Even relatively common carnivores such as the leopard are declining in most of their range.

There is an urgent need for a renewed effort throughout most of the continent to reverse the negative trends and secure the persistence of the remaining populations. In a continent where human populations are fast increasing and their impact continues to spread throughout every type of habitat, it is of paramount importance to focus on the sustainability of the coexistence between humans and carnivores. This implies implementing effective tools to prevent carnivore attacks on livestock, prevent the spread of diseases into wild populations and ensure the viability of wild prey populations which are the natural food source for the carnivores.

A new grant of 12 million euros from the European Commission to IUCN aims to provide a substantial support to conservation efforts aimed at improving the coexistence of African carnivores with increasing human populations. The new initiative, managed by the IUCN programme Save Our Species (SOS) and called the SOS African Wildlife programme, will enable coordinated conservation work across the species' natural habitats covering projects on carnivores and their prey.

The new programme will specifically focus on human-wildlife conflicts, which are at the root of much of the decline, by providing support to projects on prevention and mitigation of conflicts. The programme will also address the need for more effective anti-poaching efforts which comply with the aims of the EU strategic approach to Wildlife Conservation in Africa, "Larger than Elephants".

For SOS, this initiative is an excellent opportunity to reaffirm the role of the IUCN's Species Survival Commission (SSC) as an important contributor to efforts to protect threatened species. Since it was founded in 2010, SOS has awarded more than 100 projects on over 250 species worldwide, and the African Wildlife programme is the first to focus on the coexistence of human and carnivores.

A call for project proposals opened inviting NGOs and all civil society organisations to apply.

www.iucn.org
www.saveourspecies.org

ABSTRACTS OF SCIENTIFIC ARTICLES

PREVENTION METHODS

HOW TO AVOID DEPREDATION ON LIVESTOCK BY WOLF - THEORIES AND TESTS

E. Stoynov, A. Grozdanov, S. Stanchev, H. Peshev, N. Vangelova, D. Peshev
Bulgarian Journal of Agricultural Science 20(1) / ***2014***

To minimize and avoid Man/Predators conflict based on depredation on livestock and to secure safe environment for the vultures in SW Bulgaria, where the usage of poison baits as a revenge towards predators is a serious threat, we have studied wolf (*Canis lupus Linnaeus*, 1758)- livestock conflict in the Struma River Valley and surrounding mountains. We have investigated patterns over 300 verified wolf attacks on livestock between 2004 and 2013. Although we used different methodology to obtain data (namely claims for compensation instead of inquiry), but also longer period of collection, our data generally supports the statement of Iliopoulos et al. (2009) concerning the expectations of depredation on different livestock types in terms of their availability. Most of the results we had received fully resembled these of the cited study in Central Greece. We set up and tested some theories in order to avoid or minimize livestock depredation as follows: 1. The higher the number of the herd, the higher the exposition to depredation; 2. The higher the number of the guarding dogs, the lesser the depredation rate; 3. The mixed herds of sheep and goats are more exposed to depredation than the herds of sheep and goats raised separately; 4. The goats are more exposed to depredation because of their grazing habits; 5. Improving the night corrals for sheep and goats eliminates the extreme cases of depredation; 6. The herds grazing on rough terrain and bushy pastures with forest patches are more exposed to depredation; 7. Shifting from sheep or goats rearing to cattle breeding may reduce the rate of depredation in certain holdings. All mentioned theories were proven to be true with different rate of significance. There are two, #5 and #7, that we consider could drastically change the situation and decrease the rate of depredation over livestock in SW Bulgaria while some important specific measures should be applied. We have noticed that the actual rate of depredated cattle comes from the higher portion of killed calves up to 120 kg live body mass. The total percentage of depredated cattle is 13.67% of all reported cases, (10.16% attacks over calves with less than 120 kg body mass and 3.51% cows). This might have conservation implications, if calves were kept in enclosures and weren't exposed to predators until reaching higher body mass. We proposed two livestock breeders to shift from sheep and mixed sheep and goat herds to cattle. Thus one of the involved livestock breeders in the experiment has shifted from 120 sheep to about 20 cows, while the other from 120 sheep and 50 goats established a new herd of 25 cows. The two herds increased soon after to 32 and 41 cows and calves respectively. From about 40 and 60 depredation cases over the projected sheep and mixed sheep and goats herds in 2010 and 2011 the newly established cattle herds were not attacked at all for the period 2012-October 2013, although the wolf presence was still noticed in the observed areas.

WOLF PREDATION ON CATTLE IN PORTUGAL: ASSESSING THE EFFECTS OF HUSBANDRY SYSTEMS

Virgínia Pimenta, Inês Barroso, Luigi Boitani, Pedro Beja
Biological Conservation 207, 17–26 / ***2017***

Mitigating conflicts associated with predation on livestock is essential for conserving large carnivores in human dominated landscapes. This is generally addressed by targeting individual management practices affecting predation risk, often disregarding that different livestock husbandry systems (i.e., groups of farms sharing similar resource bases, production patterns and management practices) with different vulnerabilities to predation may coexist within predator ranges, each of which requiring tailored prescriptions to reduce

predation. Here, we evaluated the importance of considering both husbandry systems and individual management practices to mitigate conflicts due to cattle predation by wolves in Portugal, where attacks on cattle increased >3 times in 1999–2013. Government records from 2012 to 2013 indicated that only <2% of cattle farms suffered wolf attacks, of which <4% had >10 attacks per year. We found that attacks were concentrated in the free-ranging husbandry system, which was characterized by multi-owner herds, largely grazing communal land far from shelter, and seldom confined. Protecting these herds at night in winter was the most important factor reducing wolf attacks, which could be achieved by changing practices of ≈25% of farmers in this system. Attacks were much lower in the semi-confined system, probably because herds grazed pastures closer to shelter, and they were often confined with fences or in barns. Farms bringing calves <3 months old to pastures were associated with about 90% of attacks, but changing this practice would involve ≈50% of farmers in this system. Our results underline the importance of identifying livestock husbandry systems and to adjust mitigation strategies to each system.

IMPACTS OF LARGE CARNIVORES

THE COMPARATIVE EFFECTS OF LARGE CARNIVORES ON THE ACQUISITION OF CARRION BY SCAVENGERS

Maximilian L. Allen, L. Mark Elbroch, Christopher C. Wilmers, Heiko U. Wittmer
The American Naturalist 185, 822-33 / ***2015***

Pumas (Puma concolor) and black bears (Ursus americanus) are large carnivores that may influence scavenger population dynamics. We used motion-triggered video cameras deployed at deer carcasses to determine how pumas and black bears affected three aspects of carrion acquisition by scavengers: presence, total feeding time, and mean feeding-bout duration. We found that pumas were unable to limit acquisition of carrion by large carnivores but did limit aspects of carrion acquisition by both birds and mesocarnivores. Through their suppression of mesocarnivores and birds, pumas apparently initiated a cascading pattern and increased carrion acquisition by small carnivores. In contrast, black bears monopolized carrion resources and generally had larger limiting effects on carrion acquisition by all scavengers. Black bears also limited puma feeding behaviors at puma kills, which may require pumas to compensate for energetic losses through increasing their kill rates of ungulates. Our results suggest that pumas provide carrion and selectively influence species acquiring carrion, while black bears limit carrion availability to all other scavengers. These results suggest that the effects of large carnivores on scavengers depend on attributes of both carnivores and scavengers (including size) and that competition for carcasses may result in intraguild predation as well as mesocarnivore release.

TOP CARNIVORES INCREASE THEIR KILL RATES ON PREY AS A RESPONSE TO HUMAN-INDUCED FEAR

Justine A. Smith, Yiwei Wang, Christopher C.Wilmers
Proc. Royal Society. B. 282, 20142711 / ***2015***

The fear induced by predators on their prey is well known to cause behavioural adjustments by prey that can ripple through food webs. Little is known, however, about the analogous impacts of humans as perceived top predators on the foraging behaviour of carnivores. Here, we investigate the influence of human-induced fear on puma foraging behaviour using location and prey consumption data from 30 tagged individuals living along a gradient of human development. We observed strong behavioural responses by female pumas to human development, whereby their fidelity to kill sites and overall consumption time of prey declined with increasing housing density by 36 and 42%, respectively. Females responded to this decline in prey consumption time by increasing the number of deer they killed in high housing density areas by 36% over what they killed in areas with little residential development. The loss of food from declines in prey consumption time paired with increases in energetic costs associated with killing more prey may have consequences for puma populations, particularly with regard to reproductive success. In addition, greater carcass availability is likely to alter community dynamics by augmenting food resources for scavengers. In light of the extensive and growing impact of habitat modification, our study emphasizes that knowledge of the indirect effects of human activity on animal behaviour is a necessary component in understanding anthropogenic impacts on community dynamics and food web function.

HUMAN DIMENSIONS

WHY HAS HUMAN-CARNIVORE CONFLICT NOT BEEN RESOLVED IN NAMIBIA?

Niki A. Rust, Joseph Tzanopoulos, Tatyana Humle, Douglas C. MacMillan
Society & Natural Resources 29, 1079-1094 / ***2016***

Human–wildlife conflict has historically been portrayed as a management problem where solutions lie in technical changes or financial incentives. However, recent research shows many conflicts stem from social, economic, and political drivers. We undertook qualitative data collection on livestock farms to determine whether relationships between farmers and their workers affected frequency of reported livestock depredation in Namibia. We found that the conflict was affected by social and economic inequalities embedded in the previous apartheid regime. Macro and microlevel socioeconomic problems created an environment where livestock depredation was exacerbated by unmotivated farm workers. Poor treatment of workers by farmers resulted in vengeful behaviors, such as livestock theft and wildlife poaching. Successfully addressing this situation therefore requires recognition and understanding of its complexity, rather than reducing it to its most simplistic parts.

CONSERVATION SOCIAL SCIENCE: UNDERSTANDING AND INTEGRATING HUMAN DIMENSIONS TO IMPROVE CONSERVATION

Nathan J. Bennett, Robin Roth, Sarah C. Klain, Kai Chan, Patrick Christie, Douglas A. Clark, Georgina Cullman, Deborah Curran, Trevor J. Durbin, Graham Epstein, Alison Greenberg, Michael P Nelson, John Sandlos, Richard Stedman, Tara L Teel, Rebecca Thomas, Diogo Veríssimo, Carina Wyborn
Biological Conservation 205, 93-108 / ***2017***

It has long been claimed that a better understanding of human or social dimensions of environmental issues will improve conservation. The social sciences are one important means through which researchers and practitioners can attain that better understanding. Yet, a lack of awareness of the scope and uncertainty about the purpose of the conservation social sciences impedes the conservation community's effective engagement with the human dimensions. This paper examines the scope and purpose of eighteen subfields of classic, interdisciplinary and applied conservation social sciences and articulates ten distinct contributions that the social sciences can make to understanding and improving conservation. In brief, the conservation social sciences can be valuable to conservation for descriptive, diagnostic, disruptive, reflexive, generative, innovative, or instrumental reasons. This review and supporting materials provides a succinct yet comprehensive reference for conservation scientists and practitioners. We contend that the social sciences can help facilitate conservation policies, actions and outcomes that are more legitimate, salient, robust and effective.

BOOKS

Lynx, Regards Croisés (Lynx, Crossed Looks)

By Laurent Geslin/ **2014** / Editions Slatkine / 160 pp

Lynx, Crossed Looks reveals over 140 surprising photographs of Europe's largest cat taken in its natural environment. These images are the fruit of several years of work, hundreds of hours (even days) of observations and sophisticated camera traps. The book's 160 pages are punctuated by commentaries from the greatest European species specialists, opinions from field actors (rangers, foresters, biologists and hunters) and extraordinary observations by wildlife enthusiasts.

Ecology, Evolution and Behaviour of Wild Cattle: Implications for Conservation

Edited by Mario Melletti and James Burton / **2014**
Cambridge University Press / 512 pp

Covering all thirteen species, Ecology, Evolution and Behaviour of Wild Cattle brings together contributions by international leading experts on the Bovini tribe to provide: a comprehensive review of current knowledge on systematic, anatomy and ecology of wild cattle; a clear understanding of the conservation status of each species and gaps in current knowledge; a number of case studies on conservation activities and an investigation of some of the most threatened and least known species. An invaluable resource for students, researchers and professionals in behavioural ecology, evolutionary biology and conservation biology, this beautifully illustrated reference work reveals the extraordinary link between wild cattle and humans, the benefits some of these species have brought us and their key roles in natural ecosystems.

Escaping From Predators: An Integrative View of Escape Decisions

Edited by William E. Cooper Jr. and Daniel T. Blumstein
2015 / Cambridge University Press / 460 pp

When a predator attacks, prey are faced with a series of 'if', 'when' and 'how' escape decisions; these critical questions are the focus of this book. Cooper and Blumstein bring together a balance of theory and empirical research to summarise over fifty years of scattered research and benchmark current thinking in the rapidly expanding literature on the behavioural ecology of escaping. The book consolidates current and new behaviour models with taxonomically divided empirical chapters that demonstrate the application of escape theory to different groups. The chapters integrate behaviour with physiology, genetics and evolution to lead the reader through the complex decisions faced by prey during a predator attack, examining how these decisions interact with life history and individual variation. The chapter on best practice field methodology and the ideas for future research presented throughout, ensure this volume is practical as well as informative.

Wolves on the Hunt: The Behavior of Wolves Hunting Wild Prey

By L. David Mech, Douglas Smith and Daniel MacNulty
2015 / The University of Chicago Press / 208 pp

The interactions between apex predators and their prey are some of the most awesome and meaningful in nature: displays of strength, endurance, and a deep co-evolutionary history. There is perhaps no apex predator more impressive and important - or more infamous and misjudged - than the wolf. Due to their habitats, speed and ability to evade humans, researchers have faced great obstacles in studying wolves' natural hunting behaviours. The first book to focus explicitly on wolf hunting of wild prey, Wolves on the Hunt seeks to fill these gaps in our knowledge and understanding.

Combining behavioural data, thousands of hours of original field observations, literature review, a wealth of illustrations, and - in the e-book edition and online - video segments from cinematographer Robert K. Landis, the authors create a compelling and complex picture. The wolf is indeed an adept killer, able to take down prey much larger than itself. While adapted to hunt primarily hoofed animals, a wolf - or especially a pack of wolves - can kill individuals of just about any species. But, even as wolves help drive the underlying rhythms of the ecosystems they inhabit, their evolutionary prowess comes at a cost: wolves spend one-third of their time hunting - the most time-consuming of all wolf activities - and success at the hunt only comes through traveling long distances, persisting in the face of regular failure, detecting and taking advantage of deficiencies in the physical condition of individual prey, and through ceaseless trial and error, all while risking injury or death.

By describing and analysing the behaviours wolves use to hunt and kill various wild prey - including deer, moose, caribou, elk, Dall sheep, mountain goats, bison, musk oxen, arctic hares, beavers, and others - Wolves on the Hunt provides a revelatory portrait of one of nature's greatest hunters.

*Texts from the books' publishers.

Pferd und Wolf: Wege zur Koexistenz (Horse and Wolf: Ways to Coexistence)

By Markus Bathen, Olaf Buschmann, Theo Gruntjens, Moritz Klose, Hannelore Martin, Torsten Richter and Ernst-Hermann Solmsen/ **2015**
NABU-Bundesverband / 21 pp

This German publication aims to synthesise experience from around the world where horses and wolves live in close proximity. Although the databases of each country are not sufficient, this publication gives a good overview of the actual situation. The work centres on a fairly complete analysis of the existing literature on the specific topic of wolf predation on horses. The conclusions are adapted to the specific context of horse breeding in Germany and agricultural and topographical structures. Through comparison with other countries there are some interesting aspects that could be instructive in learning how to avoid damages and to improve the coexistence of horses and wolves.

How Dogs Work

By Raymond Coppinger and Mark Feinstein / **2015**
The University of Chicago Presss / 224 pp

How well do we really know dogs? People may enjoy thinking about them as "man's best friend," but what actually drives the things they do? Approaching dogs as a biological species rather than just as pets, Coppinger and Feinstein accessibly synthesize decades of research and field experiments to explain the evolutionary foundations underlying dog behaviours. They examine the central importance of the shape of dogs: how their physical body (including the genes and the brain) affects behaviour, how shape interacts with the environment as animals grow, and how all of this has developed over time. Shape, they tell us, is what makes a champion sled dog or a Border collie that can successfully herd sheep. Other chapters in How Dogs Work explore such mysteries as why dogs play; whether dogs have minds, and if so what kinds of things they might know; why dogs bark; how dogs feed and forage; and the influence of the early relationship between mother and pup. Going far beyond the cosy lap dog, Coppinger and Feinstein are equally fascinated by what we can learn from the adaptations of dogs, wolves, coyotes, jackals, dingoes, and even pumas in the wild, as well as the behaviour of working animals like guarding and herding dogs.

What is a Dog?

By Raymond Coppinger and Lorna Coppinger / **2016**
The University of Chicago Press / 272 pp

Of the world's dogs, less than two hundred million are pets. Roaming the planet are five times as many dogs who are their own masters: neighbourhood dogs, dump dogs, mountain dogs. They are dogs, not companions, and these dogs, like pigeons or squirrels, are highly adapted scavengers who have evolved to fit particular niches in the vicinity of humans. In What Is a Dog? experts on dog behaviour Raymond and Lorna Coppinger present an eye-opening analysis of the evolution and adaptations of these unleashed dogs and what they can reveal about the species as a whole.

Exploring the natural history of these animals, the Coppingers explain how the village dogs of Vietnam, India, Africa, and Mexico are strikingly similar. These feral dogs, argue the Coppingers, are in fact the truly archetypal dogs, nearly uniform in size and shape and incredibly self-sufficient. Drawing on nearly five decades of research, they show how dogs actually domesticated themselves in order to become efficient scavengers of human refuse. The Coppingers also examine the behavioural characteristics that enable dogs to live successfully and to reproduce, unconstrained by humans, in environments that we ordinarily do not think of as dog-friendly.

Chevaux des Abruzzes: Entre Loups et Ours (Abruzzo Horses: Among Wolves and Bears)

By Patrice Raydelet / **2016**
Editions du Belvédère / 144 pp

The life of horses in Abruzzo, central Italy, is different from that of their fellows elsewhere. Most of them are used for riding at horse-riding centres or during walks in an authentic nature. Some carry bundles of dead wood, or are employed in logging. What practically all of them have in common is that they live a large part of the year in complete freedom, in an environment they share with the wolf and the bear. Through a gallery of more than 150 photographs, Patrice Raydelet reveals the Abruzzo horses in intimate detail. Presenting sumptuous mountain scenery, wild horses and wildlife, the author invites readers to discover the relationships that govern the lives of men, horses, wolves and bears in this unique area. This book is a hymn to the sharing of nature, where everyone has a place, so that the lessons that can be learned from this example of Italian cohabitation extend well beyond the Apennines.

MEETINGS OF INTEREST

International Urban Wildlife Conference
4-7 June 2017
San Diego, California, USA
www.urban-wildlife.org

Ecological and Social Dimensions of Tropical Biodiversity Conservation
16-21 July 2017
Merida, Yucatán, México
www.atbc2017.org

28th International Congress for Conservation Biology
23-27 July 2017
Cartagena, Columbia
conbio.org/mini-sites/iccb-2017

COMING TOPICS

The next issue of CDPNews will focus on current shepherding practices and their implications for large carnivore conservation and damage prevention. Next in line will be an issue focusing on the use of livestock guarding dogs worldwide followed by an issue looking into socio-economic aspects of damage prevention. If you are working on a project or study dealing with these topics please send us a proposal for an article. Contact us in advance for authors' guidelines.
Thank you for your collaboration!
The Editors

To be added to the mailing list or for further information, contacts us at: lifemedwolf@fc.ul.pt

You can download the Carnivore Damage Prevention News on the MedWolf website:

www.medwolf.eu

CDPnews

Carnivore Damage Prevention