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REPORT OF CHAIR OF THE WORKING PLATFORM
“Large carnivores, wild ungulates and society (WISO)”
on the mandate 2015-2016

1. Overview of mandate 2015 - 2016

Summary of the main mandate points

The Platform “Large carnivores, wild ungulates and society (WISO)” was set up by the X Alpine Conference in 2009. Liechtenstein was assigned the first presidency. Switzerland was allocated the second presidency and Italy the third and fourth (current) presidency.

The WISO platform aims at finding solutions to manage large carnivores, wild ungulates and societies harmoniously, beyond ecological aspects, taking into account social and economic aspects at an equal level.

More specifically the 2015/16 mandate foresaw:

1. to finalize drafting of practical goals and management options for wolf and lynx populations, to present these options to the relevant bodies of the AC in 2016;
2. to develop procedures among the parties which ensure a transparent flow of information and supports decision-making processes and coordination of responding actions for wolf and bear; common interpretation of behaviour of problem bear; more effective and coordinated conservation actions for the lynx, involving stakeholders;
3. to continue the development of coordinated programmes of genetic monitoring of wolves and bears on an Alpine scale, and to ensure a profound understanding of the genetic risks for the conservation of the lynx;

The goals listed above were pursued taking into account the results of the RowAlps project and other relevant projects, including EU-funded projects and other relevant initiatives.

2. Meetings and activities

Report on activities carried out (including meetings, conferences)

The first meeting was held in Rome on the 29th May 2015.

The second meeting was held in Nova Levante (Bolzano) on the 29th- 30th September 2015.

The third extended meeting was held in Valdieri (Cuneo) on the 20th -21st January 2016.

3. Outputs

Description of main outputs achieved

During the first meeting in Rome the platform:

1. approved the product of Working group 1 of the RowAlps Project;
2. endorsed the “Final report for the pilot action: defining, preventing, and reacting to problem Bear behaviour in Europe” that indeed represents a useful technical guidance on the issue;
3. encouraged countries of the Alpine region to exchange information on the wolf populations in their territory;
4. presented the opinion that the Working group 2 and Working group 3 of the RowAlps Project should focus on general criteria of management, and work on a product focusing only on criteria and not on quantitative values. There was no formal agreement on this proposal (this version of the point was discussed and agreed during the second meeting, in Nova Levante).

During the second meeting in Nova Levante the platform:

1. adopted the RowAlps reports “Lynx and Wolf in the Alps: Recommendations for an internationally coordinated management” as part of the WISO Platform report to be accompanied by an introductory remark that says both reports should be considered as a living documents that should be further developed as new data, approaches or methodologies come to light, referring particularly to the definition of the European parameter (Directive 92/43/CEE) “Favourable conservation status” of populations.

During the meeting updates on the Life WolfAlps project, Life DinAlp Bear project and Ulyca project were given.

1. The Slovenian delegation proposed to prepare a report on the management of bears and invited Switzerland and Germany to join the Life DinAlp project in order to prepare a full Alpine (plus Croatia) report. Both countries expressed the interest to be part of the group, the Platform welcomed this initiative.

During the third meeting in Valdieri the platform:

1. discussed a draft proposal for the mandate 2017 - 2018 to be proposed to the Alpine Convention bodies;
2. discussed the new genotyping approach to monitor the Bear and Wolf alpine populations presented by Laboratoire d'Ecologie Alpine (LECA);
3. endorsed the work of the Life DinAlp Bear and the Bear Alpine Group about the establishment of common guidelines for population level brown bear management in order to possibly adopt them.

An overview of the Life WolfAlps project, its products and goals, was given, along with an Update on Wolf Managements Tools in Italy.

4. Cooperation with other WGs/PFs

Description of cooperation initiatives and activities with other WGs/PFs

The WISO platform and the ECONET have established cooperation primarily by participating in each other's meetings.

A close cooperation with the ECONET platform was proposed also for the next mandate period.

5. Links to EUSALP

Description of concrete links and contribution to EUSALP

The core activities of the WISO platform aiming at the conservation and management of large carnivores were in line with EUSALP, especially in the context of natural resources and resources management and, more specifically, in the area of biodiversity and connectivity.

6. Attachments

List of the attached documents

1. Final report for the pilot action: defining, preventing, and reacting to problem Bear behaviour in Europe;
2. Lynx and Wolf in the Alps: Recommendations for an internationally coordinated management .



Defining, preventing, and reacting to problem bear behaviour in Europe

2015



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Head of Unit

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Subject: Technical report

"Defining, preventing, and reacting to problem bear behaviour in Europe"

With this note I bring to your attention the attached technical report, prepared under a service contract as part of the EU Large Carnivore Initiative.

The preparation of this document was one of the four "pilot actions" through which DG Environment intended to assist not only the national authorities but also different stakeholder groups to respond to the challenges posed to people by sharing the European landscapes with large carnivores. We chose this topic because this is an example of finding solutions to conflicts stemming from multiple sources. On the one hand, often a few "problem" bear individuals cause most of the incidents, so special attention needs to be given to preventing the development of repetitive conflict behaviour. On the other hand, people can also cause the conflicts by not preventing bears' access to anthropogenic food. Hence public education is in many cases the most effective approach especially when local inhabitants are actively involved.

In addition, the topic is of high significance for public safety and hence it receives a lot of media attention, and also because of the possible conservation consequences of any incidence.

I hope that you and your organization will find the analyses and proposals for responses a useful guide, whether you work for a public authority or you are a stakeholder living and working in an area where bears are present, or likely to appear.

I wish to thank all those who contributed to development of this document.

Yours sincerely



Stefan Leiner

Annex: Final report for the pilot action: Defining, preventing, and reacting to problem bear behaviour in Europe. Institute of Applied Ecology (Rome, Italy). Report to DG Environment, European Commission, Bruxelles. Contract no. 07.0307/2013/654446/SER/B3.

FINAL REPORT FOR THE PILOT ACTION: DEFINING, PREVENTING, AND REACTING TO PROBLEM BEAR BEHAVIOUR IN EUROPE

DECEMBER 2014

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SUMMARY

Throughout the history people have been coming into conflicts with bears. Good understanding of causes for human-bear conflicts is the first step for their effective resolution. In this report we review existing knowledge of human-bear conflicts and experiences with different conflict mitigation measures, provide an overview of official frameworks for dealing with problem bears in 15 European countries, and develop a set of recommendations for effective management of problematic bear behaviour. The recommendations have been developed by 34 European brown bear experts that have met twice, once in Ljubljana (Slovenia) and once in Venzone (Italy) during 2014.

Human-bear conflicts are very diverse and are mainly connected with bear's opportunistic foraging and consumption of food. Several factors affect risk of human-bear conflict and probably most important is access to anthropogenic food (garbage, slaughter remains etc.). Key factor is also the number of problem bears. Although such bears represent only a small part of bear population, they usually cause majority of all human-bear conflicts, while most other bears come into conflict only rarely or never.

Common characteristic of problem bears is that during their lives they have changed their behaviour through the processes of habituation to human presence or conditioning to anthropogenic food. Habituation is a process involving a reduction in response over time as bears learn that there are neither adverse nor beneficial consequences of the occurrence of the stimulus, in this case presence of a human. Operant conditioning is a learning process, in which behaviour is strengthened or weakened via consequences, such as reward or punishment. Food-conditioning is a type of operant conditioning, in which an animal learns to associate a given neutral stimulus (e.g. a presence of people) with reward in a form of high caloric food (e.g. various anthropogenic food sources, such as garbage). Operant conditioning can also be applied for management of human-bear conflict situations. Most common is aversive conditioning, which denotes procedure when a negative stimulus is used to prevent unwanted behaviour. Effectiveness of aversive conditioning depends on several factors, such as context in which learning process took place, immediacy of a consequence of given behavioural response, consistency and magnitude of these consequence and rewarding of alternative behaviour.

There are several factors that have been reported to affect the probability of occurrence of human-bears conflicts and other bear incidents: season, natural food availability, cover for bears, sex, age and reproductive status of a bear, habituation to human presence and food conditioning, availability of anthropogenic food sources, livestock husbandry, hunting and several factors that affect the probability of attack on humans (wounded bear, presence of cubs, presence of carcass used by a bear, proximity to a den, and the presence of dog).

People developed various measures to prevent human-bear conflicts. Aversive conditioning of bears, as well as other wildlife, was in general met with mixed results. Measures were usually effective for a short-term, while long-term behavioural changes were often limited. However, certain patterns that emerged through the review indicate that in specific situations some of the aversive stimuli can be effective when applied properly. Well-established monitoring that quickly detects such behaviours is crucial for successful application of aversive conditioning. Pain stimuli (e.g. rubber bullets) proved to be the most successful, although also taste aversion can be effective for specific foods. Prevention of access to anthropogenic food sources must be assured in order to achieve full effectiveness of aversive conditioning. It must be understood that application of aversive conditioning can be very costly and demand considerable effort. Based on current knowledge, aversive conditioning of bears is most warranted in the following cases:

- when potential conflict behaviour is detected early in the development of a problem bear
- when short-term solution is needed
- when adequate resources are available for continuous treatments for each problem bear
- when possibilities for lethal removal are limited

Lethal removal can be effective short-term solution for individuals strongly habituated to human presence or conditioned to anthropogenic food. However, these measures must be coupled with effective measures to prevent development of new problem bears. Limiting access to anthropogenic food is often regarded as the most effective way to prevent conflicts with bears, with success rates up to >90% reduction of human-bear incidents. Experiences suggest that this approach gives best results when local inhabitants are actively involved. Other potentially effective measures for preventing human-bear conflicts include use of bear spray to deter bear attacks on humans and adjustments in land-use practices (e.g. transition from sheep to cattle farming, maintaining open landscape around human settlements). Compensations can, when well-designed, address inequities of distribution of damages caused by bears across society and improve tolerance towards bears, but do not affect occurrence of bear incidents.

The analysis of existing scientific knowledge would suggest that preventive proactive measures should be a priority, European brown bear management plans mostly deal with reactive management. The documents provide variable level of detail, but generally foresee following management measures: close monitoring, aversive conditioning, removal or fencing of the attractant, removal of individual animals (lethal or translocations to nature/captivity), compensations for the damages, information campaigns. Sometimes special emergency teams are formed which are in charge for implementation of urgent actions regarding problem bear management. Proactive management aimed at preventing occurrence of problem bears is often related to implementation of individual projects and in most cases it is not systematically organized. Such measures include: prevention of damages to agriculture, prevention of access to organic waste, enhancing the trophic value of bear habitat (i.e. feeding of bears at feeding stations, planting of wild fruit trees), information campaigns to influence problematic human behaviour (intentional or unintentional feeding or disturbing of bears), dialogue with stakeholders, emergency teams, green bridges and specific road signs, abandoning the practice of rehabilitation of orphaned bears.

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INTRODUCTION

Throughout the history people have been coming into conflicts with bears and often the first choice in dealing with these kind of problems was to kill bears (Schwartz et al. 2005; Treves et al. 2006).. Consequently, together with other anthropogenic effects, such as habitat loss, bear numbers throughout the world decreased and many populations became extinct. In response to these threats and in line with public's increasing ecological awareness, many of the surviving bear populations received at least some level of protection. Nowadays, several bear populations recovered and continue to increase. Among them are majority of the brown bear (*Ursus arctos*) populations in Europe (Kaczensky et al. 2012). Increased bear numbers and re-colonization of part of the former distribution range led again to the increasing number of bear incidents and human-bear conflicts. However, today possibilities of lethal removal of bears are becoming increasingly limited, due to decreasing public tolerance to killing bears and legal limitations in management of endangered wildlife (Schwartz et al. 2005). This is especially pronounced in regions with small and threatened bear populations and general positive public attitude towards bears. But even here there is a great need for effective conflict mitigation measures, if long-term survival of bear is to be achieved. High conflict rate can decrease public attitude towards bears and prevent co-existence of bears and local communities, which is the only option for maintaining viable bear populations in Europe.

This new situation calls for a change in dealing with human-bear conflicts from lethal reactive to proactive, preferably non-lethal and preventive approach. In general, such proactive management is also met with higher success (Hopkins et al. 2012). Nevertheless, there will probably always be occasions when certain bear will have to be removed. In such cases, clear and well-argued science-based message needs to be provided to the public, explaining why this measure was necessary in a given case.

To be able to prepare successful management plans and protocols for addressing various human-bear conflicts, managers and decision-makers need good understanding of causes for human-bear conflicts and effectiveness of potential conflict mitigation measures.

The main goals of this report are to: 1.) provide theoretical background for conflict behaviour of bears and possibilities to change it, 2.) review factors affecting predisposition of certain bears or situations for occurrence of human-bear conflicts, and 3.) review effectiveness of existing conflict mitigation measures with special focus on aversive conditioning.

Although we are aware that people's subjective perception of the bear incidents plays crucial role in the severity of conflicts and can importantly influence the decisions taken by bear managers, in this report the focus was primarily on bear- and environment-related factors and objective measures of the effectiveness of conflict mitigation methods. Nevertheless we stress the importance of systematic studies of local people's perceptions and participatory approach in

large carnivore management, as already noted by several authors (e.g. Treves et al. 2006, Bath 2009, Linnell et al. 2013).

SUMMARY OF EXISTING KNOWLEDGE

1.1 TERMINOLOGY

Terminology used in this report generally follows proposed lexicon of terms and concepts for human–bear management in North America:

anthropogenic food: foods or attractants having a human origin

aversive conditioning: a learning process in which deterrents are continually and consistently administered to a bear to reduce the frequency of an undesirable behaviour

bear deterrent: aversive agent administered to bears to cause pain, avoidance, or irritation

bear incident: an occurrence that involved a human–bear conflict or episodes where bears caused property damage, obtained anthropogenic food, killed or attempted to kill livestock or pets, or were involved in vehicle collisions

food-conditioned bear: a bear that has learned to associate people (or the smell of people), human activities, human-use areas, or food storage receptacles with anthropogenic food

habituated bear: a bear that shows little to no overt reaction to people as a result of being repeatedly exposed to anthropogenic stimuli without substantial consequence; note: since usually the evidence for the cause of this low reaction to people is lacking, a term *bear tolerant to people* might be more correct in some cases

human–bear conflict: a subset of bear incidents that transpired during the incident when 1) a bear has exhibited stress-related or curious behaviour, causing a person to take extreme evasive action (the person felt threatened by the bear’s behaviour), 2) made physical contact with a person or exhibited clear predatory behaviour, or 3) was intentionally harmed or killed (not including legal harvests) by a person

management removal: lethal or non-lethal removal of a bear from the population by or at the direction of management personnel

proactive human–bear management: a population-level management strategy that aims to deter or prevent individual bears not previously or currently involved in bear incidents from being involved in incidents

problem bear: a bear involved in repeated bear incidents

reactive human–bear management: a management strategy that responds to individual bears involved in bear incidents through immediate and direct action or increases the harvest of a local population of bears in an attempt to reduce bear incidents

1.2 THEORETICAL BACKGROUND FOR CHANGES IN BEAR BEHAVIOUR

Existing information of human-bear conflicts suggests that large part of conflicts is caused by relatively small number of bears. Common characteristic of these “problem” bears is that during their lives they have changed their behaviour through processes like habituation to human presence and conditioning to anthropogenic food (Herrero 2002; Smith et al. 2005). On the other hand, there is potential that these behavioural changes could be reversed through the learning process, such as aversive conditioning (Gillin et al. 1995). In this section we present the theoretical background for these behavioural processes that affect bear’s conflict potential.

1.2.1 HABITUATION AND TOLERANCE

On neurological level, habituation is defined as a behavioural response decrement that results from repeated stimulation and that does not involve sensory adaptation, sensory fatigue or motor fatigue (Rankin et al. 2009). Applied to bear behaviour, behavioural habituation refers to the waning of a response to a repeated, neutral stimuli in the absence of reward or punishment (McCullough 1982; Whittaker and Knight 1998). Habituation is thus a process involving a reduction in response over time as individuals learn that there are neither adverse nor beneficial consequences of the occurrence of the stimulus, in this case presence of a human. Therefore, habituation of bears to humans refers to the loss of avoidance and escape responses (Smith et al. 2005). These bears that lost fear of people are then referred to as “habituated bears”.

In literature there have been considerable confusion with the use of term habituation and habituated bears. Most commonly habituation is confused with tolerance (Smith et al. 2005). Tolerance is defined as the intensity of disturbance that an individual tolerates without responding in a defined way (Nisbet 2000). The main difference is that tolerance refers to a current *state*, while a habituation refers to a learning *process* over time (Bejder et al. 2009). Therefore a habituated bear has gone through a process of habituation and became tolerant to people, while before it was not. Theoretically, a bear could already be born tolerant to people and in this case it would be erroneous to label it as habituated. To confirm habituation in wildlife, a sequential monitoring of given individual through time is needed to document the change in tolerance (Bejder et al. 2009). For bears it is generally assumed that they initially avoid and fear people, probably due to past persecution by humans and consequent artificial selection against bold individuals (Mattson 1990; Herrero 2002). Therefore bear tolerance towards humans today is usually a consequence of habituation process. Various authors noted that habituation is sometimes also confused with terms like conditioning, attraction, or learning of a certain habit (McCullough 1982; Whittaker and Knight 1998; Hopkins et al. 2010).

Habituation is generally an adaptive mechanism, as it reduces time and energy costs by eliminating or reducing irrelevant behaviours (McCullough 1982). Interesting to note is that the process of bear habituation to humans appears to be very similar to the process of bears becoming habituated to the presence of other bears. Furthermore, observations from bear-viewing at bear aggregations around clumped food sources suggest that bear-to-bear habituation that occur at such feeding sites becomes generalized also to humans (Smith et al. 2005). This would mean that bears that became habituated to conspecifics also automatically become tolerant to humans even in the absence of people. In general, it appears that bears respond to people in a similar manner as they do to dominant bears (Herrero 2002; Dolson 2010).

1.2.2 CONDITIONING

Behavioural theory outlines two basic ways, in which learning process is promoted: classical and operant conditioning (Jenkinson 2010).

1.2.2.1 CLASSICAL CONDITIONING

Classical conditioning (or Pavlovian conditioning) refers to a learning process when a conditioned stimulus (originally a neutral stimulus) is paired with an unconditioned stimulus that already produces an unconditioned response. Through this process, animal's response to the conditioned stimulus becomes similar to the response of the unconditioned stimulus. Conditioning thus does not involve the acquisition of any new behaviour, but rather the tendency to respond in old ways to a new stimulus. In early studies conditioned, stimulus was thought to become associated with, and eventually elicits, the unconditioned response. But today it is commonly suggested that the conditioned stimulus only predicts or signals the unconditioned response (Shettleworth 2009).

A type of classical conditioning is fear conditioning, in which organisms learn to associate aversive events with a particular neutral context or neutral stimulus (Maren 2001). Through pairing of neutral stimulus (e.g. certain sound) or context (e.g. certain place) with an aversive stimulus (e.g. electric shock, rubber bullet or unpleasant noise) the neutral stimulus or context alone can eventually elicit the state of fear (which is in this case a conditional response).

Although in certain cases a single pairing of conditional and unconditional stimuli may suffice to achieve classical conditioning, usually a number of pairings are necessary. Besides the number of pairings, the effectiveness and speed of learning generally depends also on the nature and strength of the conditioned and unconditioned stimuli, as well as on the previous experience and the animal's motivational state (Bouton 2007; Shettleworth 2009).

1.2.2.2 OPERANT CONDITIONING

Operant conditioning (or *instrumental conditioning*; sometimes also simply *reinforcement*) is a learning process, in which a behaviour is strengthened or weakened via consequences (e.g. reward or punishment) of given behaviour (Bouton 2007). The animal learns to associate a reward or punishment with its behavioural response to a previously neutral stimulus and learns to repeat the behaviour, if rewarded or to avoid the behaviour, if punished. The consequences can be either positive (delivered following a response), or negative (withdrawn following a response). Positive and negative operant conditioning both cause behaviour to occur with greater frequency, whereas positive or negative punishment will decrease the likelihood the behaviour will occur again.

Food-conditioning is a type of operant conditioning, in which an animal learns to associate a given (in this context) neutral stimulus (e.g. a presence of people) with reward in a form of high caloric food (e.g. various anthropogenic food sources such as garbage).

Operant conditioning can also be applied to management of human-wildlife conflict situations. Positive punishment and negative reinforcement are the two main techniques, in which aversive control of behaviour is used as behaviour modification (Jenkinson 2010). For example, an electric shock is given after undesired behaviour is performed (positive punishment) or unpleasant sound is stopped when desired behaviour is performed (negative reinforcement). Common term used in these procedures is aversive conditioning, which denotes an operant technique that uses a negative stimulus to prevent unwanted behaviour (Mazur 2010). During aversive conditioning, an aversive agent (e.g. a painful stimulus of being hit with a rubber bullet) is administered while an animal is engaged in undesirable behaviour in order to elicit an avoidance of such behaviour in the future (Gillin et al. 1994).

Effectiveness of aversive conditioning is related to the average time needed to achieve conditioning and/or how fast the learning is extinguished (extinction is a process when a behavioural response that had previously been conditioned becomes no longer effective after the reward or punishment is stopped; McCullough 1982). This depends on several factors (Miltenberger 2007; Dolson 2010):

- 1) Context in which the learning process took place. Behaviours learned in one context may be absent, or altered, in another. For example, behaviours learned in one place (e.g. laboratory) may fail to occur elsewhere.
- 2) Satiation or Deprivation. Effectiveness of learning depends on individual's need for given source of stimulation. For example, food will be more effective reward for a hungry bear than a satiated bear.
- 3) Immediacy. If a consequence of given behavioural response is felt immediately, learning will be more effective than after longer time needed for the feedback.
- 4) Consistency. If a consequence does not consistently and reliably follow the behavioural response, its effectiveness is reduced (both through slower learning and faster extinction).

- 5) Magnitude. If the intensity or amount of the consequence (e.g. pain) is strong enough to be worth the effort to avoid it, the consequence will be more effective upon the behaviour. It is generally recommended that the aversive conditioning is already initially intense.
- 6) Rewarding alternative behaviour. Learning through punishment is generally more effective and faster, when at the same time alternative behaviour is rewarded.

1.3 FACTORS AFFECTING OCCURRENCE OF BEAR INCIDENTS

There are several factors that affect the probability of occurrence of human-bears conflicts and other bear incidents. These can be related to the environment characteristics, human practises, characteristics of bear population and predisposition of certain bear sex/age/reproductive categories and individuals to cause the conflicts. Human-bear conflicts are mainly connected with bear's opportunistic foraging and consumption of food. Consequently factors related with this behaviour often have strongest effects.

1.3.1 SEASON

Often two peaks in occurrence of bear incidents were recorded, one in spring soon after re-emergence from winter dens and the second during autumn in time of hyperphagia, when bears are building their fat reserves for hibernation (McArthur Joep 1983; Gunther et al. 2004). The autumn peak also coincides with the ripening of fruits and crops, which can attract bears closer to people (Sato et al. 2005). Potentially important effect in spring is mating season and corresponding avoidance of male bears by the subadults and females with cubs, which can bring them closer to humans (Mattson 1990; Budic 2010; Elfström et al. 2014a,b). Spring is also the time when cubs are least mobile and females tend to be more protective, thus increasing probability of attack on people. Difference between spring and autumn peak in bear incidents probably also depends on availability of natural food sources, which is important factor affecting probability for incidents and it affects primarily the autumn peak. Typically the conflict rate is lowest during winter, when large part of bear populations is hibernating.

1.3.2 NATURAL FOOD AVAILABILITY

Several studies noted considerable increase in bear incidents or/and use of anthropogenic food in years with poor natural food availability (Mattson 1990; Mattson et al. 1992; Gillin et al. 1994; Creachbaum et al. 1998; Gunther et al. 2004; Greenleaf et al. 2009). This appears to be most typical in areas with variable inter-annual masting of locally abundant tree species, such as beech, oaks, and white-bark pine. Effects are usually most pronounced in bears searching for anthropogenic foods near humans (Creachbaum et al. 1998) and increased damage caused on crops (Sato et al. 2005). On the other hand, it seems that lower food availability is neither connected with livestock depredation rates (Gunther et al. 2004), nor with attacks on people

(Herrero 2002), although Gillin et al. (1997) suggested otherwise for Russia. Recent study on American black bears (*Ursus americanus*) showed that bears coming to urban areas and causing bears incidents in years of poor natural food availability can reverse this behaviour and switch back to natural foods in years with higher natural food availability (Baruch-Mordo et al. 2014). However, there is no relation between the annual occurrences of killed problem bears near settlements and seasonal food availability, and no difference in body condition between killed problem bears and bears killed during regular hunting in either Sweden or Slovenia (Elfström et al. 2014b).

1.1.1 COVER FOR BEARS

Cover is a key habitat factor for bears, especially in human-dominated landscapes and its availability promotes bear use of areas near human settlements (Ordiz et al. 2011). Several authors noted that higher cover availability (mainly dense vegetation) around livestock pastures, crop fields, roads, villages and other developed areas increases risk for bear incidents (Kaczensky 1999; Gibeau et al. 2002; Sato et al. 2005; Wilson et al. 2006; Bereczky et al. 2011).

1.3.3 SEX, AGE AND REPRODUCTIVE STATUS OF BEARS

It has been noted throughout the world for brown bears that subadult bears and adult females accompanied by their offspring are most commonly causing bear incidents and removed as problem bears (Mattson 1990; Mattson et al. 1992; McLellan et al. 1999; Gibeau and Stevens 2005; Krofel et al. 2012b, Steyaert et al. 2013a; Elfström et al. 2014a,b). Several, mutually non-exclusive explanations have been suggested for the observed age-related bias in problem bears: 1) Naivety: subadult bears are less experienced in avoiding humans, as well as in obtaining natural foods and this brings them more frequently in contact with people and anthropogenic food sources (Elfström et al. 2014a). 2) Artificial selection: selective hunting of young problem bears removes bold bears from the population at their early age, leaving higher proportion of shy individuals among those surviving to adulthood (Krofel and Jerina 2012a). 3) Social interactions: large males displace subadults and females with cubs from best habitat to the marginal habitats near people, especially during the mating season (Mattson 1990; Mattson et al. 1992; Gibeau and Stevens 2005; Steyaert et al. 2013a,b, Elfström et al. 2014a,b). Only the social organization can explain why are females accompanied by their offspring occurring more often near settlements compared to adult males and lone adult females in order to avoid dominant bears, which also increases probability for becoming habituated to human presence or food conditioned(see next sections) (Elfström et al. 2014a). The same pattern has been observed in American black bears, with adult males more often dominating in remote areas compared to other sex/age categories of bears (for review see Elfström et al. 2014a). Subadult males seem to be more common near settlements than subadult females, especially within expanding bear populations, reflecting dispersal behaviour (Elfström et al. 2014a). On the other hand, most livestock depredations seem to be caused by males and larger bears often also kill larger animals (Mattson 1990; Bereczky et al. 2011).

1.3.4 HABITUATION TO HUMAN PRESENCE AND FOOD CONDITIONING

Habituation to human presence and conditioning to anthropogenic food are the main mechanisms through which problem bears are believed to develop (Creachbaum et al. 1998; Swenson et al. 2000; Herrero et al. 2005). Both processes seem to be accelerated with abundant and easy-to-access anthropogenic food (see next section). Habituation is also induced by frequent human presence, especially on trails rather than off-road, probably due to consistency and predictability (Jope 1985; Nisbet 2000).

Important conclusion of many case studies is that often relatively small proportion of bears cause large part of all human-bear conflicts (Zedrosser et al. 1999; Witmer and Whittaker 2001; Huber 2010; Bereczky et al. 2011; Jerina et al. 2011; Sindicic et al. 2011). Typically, these are habituated and food-conditioned bears. The same seems to be the case also with human-bear conflicts in the Alps, where numerous bear incidents were caused by small number of habituated bears, like “Jurka”, “JJ1” (Austrian Bear Emergency Team 2006), “JJ3” (Brosi et al. 2008), and “Rožnik” (Kaczensky et al. 2011). For example, during the telemetry monitoring of habituated male “Rožnik” in Slovenia, this single bear was responsible for 40% of all reported bear incidents with approximately 400-500 bears in Slovenia (Jerina et al. 2011). It also seems that public is generally less tolerant to such repeated incidents caused by the same bears than to widespread cases connected with various individuals (Ciucci and Boitani 2008; Bereczky et al. 2011).

At present it is not clear if or to what degree such behaviour (tolerance towards people and conditioning to anthropogenic food) can be transferred from female to its offspring, as has been suggested by some authors (Gillin et al. 1994; McCarthy and Seavoy 1994). Anecdotic cases such as “JJs” indicate this possibility (Austrian Bear Emergency Team 2006). On the other hand, there are also anecdotic cases of females completely habituated to people, whose offspring retained fear of people (M. Krofel, unpublished data). One study on American black bears showed that foraging on anthropogenic food is transmitted from mother to offspring through social learning (Hopkins 2013), while others did not find evidence for transmission of such foraging behaviour from females to offspring (Breck et al. 2008; Mazur and Seher 2008). No such studies are yet available for brown bears. However, cultural transmission of behaviour from mother to offspring does not explain why the females accompanied by offspring are more often near settlements than adult lone females (without offspring) and adult males (Steyaert et al. 2013a, Elfström et al. 2014a).

During encounters with people, bears habituated to human presence are generally less dangerous for humans *per encounter* (Smith et al. 2005). However, because such bears come into contact with people considerably more frequently compared to non-habituated bears, overall they usually still present higher risk for human injuries and deaths compared to non-habituated bears (Gniadek and Kendall 1998; Gunther and Hoekstra 1998; Serban-Parau 1999; Herrero 2002; Herrero and Higgins 2003; Herrero et al. 2005). Habituated bears also avoid roads to a lesser degree compared to non-habituated bears and are consequently more frequently involved

in vehicle collisions (Chruszcz et al. 2003; Gibeau and Stevens 2005). Anecdotic evidence suggests that habituated behaviour in females might be more pronounced when they have cubs (Rauer et al. 2003).

Several studies report that subadults and females accompanied by their offspring are more often using food aggregation sites during periods of increased human activity, probably reflecting avoidance of dominant conspecifics (Smith 2002; Nevin & Gilbert 2005; Rode et al. 2006; Elfström 2014a).

1.3.5 AVAILABILITY OF ANTHROPOGENIC FOOD

Free access to anthropogenic food is the main cause of human-bear conflicts and occurrence of problem bears according to numerous studies throughout North America (Jope 1985; Creachbaum et al. 1998; Herrero 2002; Herrero et al. 2005; Wilson et al. 2006; Wilson 2007), Asia (Sato et al. 2005) and Europe (Serban-Parau 1999; Swenson et al. 2000; Huber 2010; Bereczky et al. 2011; Krofel and Jerina 2012a; but see Elfström et al. 2014b, c for Scandinavia). Conflicts are also more likely to re-occur in areas with regular availability of such food sources (Knight et al. 1988; Jerina et al. 2011). For example, Wilson et al. (2006) documented that 75% of all human-bear conflicts in the study area in Montana occurred at conflict hotspots with anthropogenic foods and 82% of all human-grizzly bear conflicts were related to human foods that attracted bears. Especially problematic seem to be intentional feeding of bears directly by people, even more so if practiced in regions with high people density (Huber 2010; Sindicic et al. 2011; Krofel and Jerina 2012a).

1.3.6 LIVESTOCK HUSBANDRY

Livestock husbandry practices, especially protection measures used, are usually the main factor affecting livestock depredations by bears (Kaczensky 1999). Protection of livestock herds is important not only to deter predators in given situation, but also to prevent development of problem individuals specialized in killing livestock, as poor protection can give ample opportunities for learning of depredation habits (Linnell et al. 1999). Probability of attack is also linked to the domestic animals used. For example, sheep and goats proved to be considerably more susceptible to bear attacks than larger livestock, such as cattle and horses (Horstman and Gunson 1982; Krofel and Jerina 2012a).

1.3.7 HUNTING

Hunting can strongly affect several aspects of wildlife ecology and behaviour (Darimont et al. 2009; Cromsigt et al. 2013). Bears adjust their behaviour in response to being hunted (Ordiz et al. 2012) and long term intensive persecution of European bears is probably one of the main reasons, why bears in Europe are more shy towards people compared to bears in North America and Asia (Herrero 2002). Also today, Eurasian bears appear to be more wary of people in areas where they are still being hunted (Swenson 1999). However, even in the most hunted brown

bear populations, habituation to human presence and food-conditioning is still common (e.g. in Slovenia; Jerina et al. 2011) as availability of anthropogenic food appears to be more important factor affecting wariness than hunting (Swenson 1999).

1.3.8 FACTORS AFFECTING THE PROBABILITY OF ATTACK ON HUMANS

Several factors were shown to increase the risk of bear attack on people during human-bear encounters. These include, in decreasing order of their importance: wounded bear, presence of cubs, presence of carcass used by a bear, proximity to a den, and the presence of dog (Swenson et al. 1999; Herrero 2002). In Scandinavia highest risk of bear attack was associated with hunting with dogs and sudden unexpected close encounters between hunters and bears (Sahlén 2013). In general, European brown bears are less aggressive towards people compared to brown bears in North America and Asia (Moen et al. 2012).

1.4 EFFECTIVENESS OF CONFLICT MITIGATION MEASURES

During thousands of years of coexistence with bears, people developed various more-or-less effective measures to prevent or mitigate human-bear conflicts. Here we present a review of reported measures and, when available, their effectiveness (see also Table 2). More detailed review is provided for the aversive conditioning techniques.

1.4.1 AVERSIVE CONDITIONING

1.4.1.1 OTHER WILDLIFE

Aversive conditioning has been attempted on numerous species in order to decrease human-wildlife conflicts (Jenkinson 2010). In general, these attempts have been met with mixed results. Measures were usually effective for a short-term, while long-term behavioural changes were often limited due to eventual habituation to the aversive stimuli. Higher success was observed when very specific behaviour was targeted in comparison to the attempts that required the animal to generalize aversive conditioning to less specific unwanted behaviours. Animals also tolerated more or habituated more quickly to aversive stimuli, when undesired behaviour was already strongly established or when benefits gained through this behaviour were higher. It is also evident that species-specific methods need to be developed (Jenkinson 2010).

Effectiveness of aversive conditioning as well as factors affecting it can differ considerably among species. In general, it appears that aversive conditioning is less effective for predatory than non-predatory species. For example, repeated aversive conditioning by people chasing ungulates when they approached human settlements was effective in deterring further approaches to settlements (Kloppers et al. 2005). Bioacoustic aversive conditioning in combination with structural modification effectively reduced nest construction in cliff swallows (*Petrochelidon pyrrhonota*) (Conklin et al. 2009). Aversive conditioning with hot-wired dummy utility poles was also successful in reducing mortality due to electrocution or collision with

power lines for California condor (*Gymnogyps californianus*) (Woods et al. 2007). On the other hand, attempts of aversive conditioning of predators had limited effectiveness (Shivik et al. 2003). For example, several experiments with the use of electric collars on canids did not achieve expected post-treatment effects (Andelt et al. 1999; Schultz et al. 2005; Hawley et al. 2009). Besides, in social carnivores other members of the social group did not adopt avoiding behaviour from the conditioned member (Shivik et al. 2003). It is assumed that aversive conditioning might be more effective in territorial carnivores, as conditioned individuals will defend their territory against other, non-conditioned animals (Shivik et al. 2003). Several methods of aversive conditioning (e.g. underwater electrical gradient, rubber bullets, acoustic deterrents, boat hazing, firecrackers and taste aversion) have been attempted also for several species of pinnipeds (e.g. *Eumetopias jubatus*, *Monachus schauinslandi*, *Phoca vitulina*, *Zalophus californianus*), but no long-term effects were observed (Gearin et al. 1988; Brown et al. 2007; Forrest et al. 2009; Jenkinson 2010). Aversive conditioning of African elephants (*Loxodonta africana*) using drums, fire, electric fences and disturbance or lethal shooting of members of a herd all proved ineffective, while capsicum oleoresin spray was noted to be effective immediate deterrent, but its long-term effectiveness was not tested (Osborn 2002).

1.4.1.2 URSIDS

More studies reporting results of aversive conditioning are available for American black bears than for brown bears and other bear species (Table 1). Very few reports are available for Europe, despite the fact that several countries at least occasionally employ these techniques (Rauer et al. 2003). Similar patterns reported among the species and across continents suggest that many conclusions could be extrapolated to other situations. Nevertheless, further analyses, especially reporting results of aversive conditioning on European bears, are highly recommended.

Several types of aversive conditioning have been tested on several bear species. Similar to other animals (see above), results were mixed and positive changes were often limited to short-term effects (Table 1). However, certain patterns that emerged through the review indicate that in specific situations some of the aversive stimuli can be effective when applied properly. Therefore good understanding of the benefits and drawbacks, as well as factors affecting effectiveness of this approach is needed in order to successfully apply aversive conditioning techniques to ursids.

Non-lethal measures used to deal with problem bears generally receive higher support among the public and can thus in many cases represent a suitable alternative to management removals (Gillin et al. 1994; Rauer et al. 2003; Beckmann et al. 2004). Besides changing bear nuisance behaviour, use of aversion techniques, even when effective only for short-time, can provide managers with additional time needed to organize application of other measure. It can also provide safer option for the managers since, despite concerns of early theorists that applying pain deterrents might cause bears to respond aggressively, field experiments have shown that bears generally avoid personnel and do not react to aversive conditioning with aggression

(Dolson 2010). Some of the techniques (e.g. shooting with rubber bullets) can cause minor injuries, such as broken skin of target bears, but no lasting effects of the wounds were noted (McCarthy and Seavoy 1994). Application of aversive conditioning, especially when numerous treatments are needed, can be very costly and demand considerable effort (Gillin et al. 1994; Rauer et al. 2003; Dolson 2010). Mazur (2010) for example estimated annual costs for intensive aversive conditioning of black bear in Sequoia National Park (about 350 treatments per year) to 400 \$ for materials and 4,200 \$ for personnel, which was comparable to 2,000-20,000 \$ spent annually for lethal removals in the same park.

1.4.1.2.1 TASTE STIMULI

Taste (or ingestional) aversive conditioning was tested on American black bears using thiabendazol as an illness-inducing agent. This substance has little taste, so it cannot be detected easily in food and it causes nausea, vomiting and dizziness in about 90 min after ingestion (Ternent and Garshelis 1999). This delayed time between conditioned and unconditioned stimulus is expected to weaken the association and thus effectiveness of conditioning (Gillin et al. 1994). So far results of taste aversive conditioning were mixed. For example, treating garbage cans in residential areas in Alaska with thiabendazol did not decrease further use of garbage cans by bears (McCarthy and Seavoy 1994). In contrast, treating pre-packaged military foods with thiabendazol resulted in avoidance of this previously regularly consumed food type (but not other anthropogenic foods) for over a year (Ternent and Garshelis 1999). This suggests that taste aversive conditioning can be effective way to reduce consumption of specific food items by bears, but it is not suitable technique when diverse anthropogenic food sources (e.g. miscellaneous garbage) are the attractant.

1.4.1.2.2 VISUAL, ACOUSTIC AND OLFACTORY STIMULI

Visual, acoustic and olfactory stimuli (e.g. flashlights, torches, cracker shells, loud noise, human voice, broadcasting aggressive bear vocalization, household chemicals, and dog repellents) have been sometimes successfully used as bear deterrents (i.e. chasing bear from the location when applied), but they were not effective as a aversive conditioning tool (Miller 1983; Derocher and Miller 1985; Shivik and Martin 2000). Also their effectiveness as deterrents is often limited to short-term effects, as bears often become habituated to such stimuli (The Wildlife Team 2003; Dolson 2010).

1.4.1.2.3 PAIN STIMULI

Pain stimuli proved as most successful for aversive conditioning of bears (Table 1). Numerous techniques have been used, including shooting with rubber bullets, marbles, bean bags, pyrotechnics and paintball markers, throwing rocks, spraying with pepper spray or water, darting and tranquilizing, chasing with aggressive bear dogs (e.g. Laika dogs, Karelian dogs, Blackmouth cur), and equipping bears with electric collars (Table 1). However, even with this type of

measures effectiveness can be compromised by several factors, which caused many attempts to fail. It must also be kept in mind that pain stimuli should not be used to teach a bear to avoid garbage or other attractants, but to teach bears to avoid people and prevent habituation (Dolson 2010).

Common to several reported studies was that aversive condition using pain stimuli was fairly effective in a short-term (typically 1-2 months), while long-term effects were often limited (Derocher and Miller 1985; Rauer et al. 2003; Beckmann et al. 2004; Huffman and al. 2010; Mazur 2010). As noted by Mazur (2010), in some cases, even short-term effects can be important, for example to keep bears out of developed areas long enough to install bear-proof facilities or to keep females with cubs out of humanized areas in order to prevent transferring nuisance behaviours on offspring. Same author also directly compared effectiveness of several pain stimuli and concluded that rubber bullets and chasing by people were more effective than rock-throwing, slingshots or pepper spray (Mazur 2010). Similar to canids, less effectiveness was observed for electric collars, which worked only as deterrents, but no post-treatment effects were observed (Mason et al. 2001; Mazur 2010).

Important factor improving the effectiveness of aversive conditioning was number of treatments to which individual bear was subjected (Table 1). Generally there is no single rule on number of treatments needed, as there is high individual variability. In some cases high number (even >20) repetitions are needed over several years to achieve long-term effects, although with most bears 1-12 treatments should be effective (Gillin et al. 1994; Dolson 2010; Mazur 2010; Groff et al. 2013). It was also noted that usually response is faster and lasts longer for bears that had previously received aversive conditioning treatments (McCullough 1982; Gillin et al. 1994; Mazur 2010). In some bears, however, aversive conditioning was not successful even after large number (>20) of attempts (Mazur 2010).

Common pattern that emerged from the review was that success of aversive conditioning greatly depended on the level of habituation to human presence and food-conditioning of given bear. Most authors reported that effectiveness was considerably higher for bears in an early phase of habituation and/or food-conditioning process (McCullough 1982; Gillin et al. 1994; Schirokauer and Boyd 1998; Clark et al. 2002; Herrero 2002; Rauer et al. 2003; Mazur 2010). Aversive conditioning is thus very effective tool for keeping bears that were not food-conditioned from becoming food-conditioned and a key aspect of successful aversive conditioning programs is to keep constant vigilance in order to be able to responds quickly to first signs of a bear becoming food-conditioned and/or habituated (Mazur 2010). Since younger bears had usually less opportunities to be exposed to humans and anthropogenic food in their life, several authors recommended that they should be most suitable candidates for aversive conditioning (McCullough 1982; Gillin et al. 1994; Groff et al. 2013). However, subadult bears are among bears predisposed to engage into conflict behaviour, which probably explains why in some cases lower effectiveness was observed for aversive conditioning of young bears compared to adults (Mazur 2010). The aggressive behaviour of dominant adult bears, functioning as continuous negative stimuli in more remote areas, can also explain high return rates in bears displaced by

people near settlements (e.g. by aversive conditioning and non-lethal removals), especially among predation-vulnerable individuals (Elfström et al. 2014a).

Other factors important for success of aversive conditioning include bear density, which appears to have negative effect, probably due to more intense intraspecific interactions that promotes approaching to urban areas in less dominant bears (Clark et al. 2002). From conservation perspective this is less critical, since in high density and expanding populations lethal removal is usually less problematic. Also higher intensity of aversive conditioning appears to be more effective (Dolson 2010; Groff et al. 2013), as is expected also from the theory of operant conditioning. For example, additional use of bear dogs improved the conditioning with rubber bullets (Leigh and Chamberlain 2008) and higher number of dogs was more successful at deterring a bear permanently from a conflict site than use of a single dog (Gillin et al. 1997). However, some managers advise that intensity of aversive conditioning should be used in progressive manner (The Wildlife Team 2003). Another important factor is timing of application of negative stimulus in respect to the bear activity. Ideally, negative reinforcement should occur within 2 seconds of the bear exhibiting undesirable behaviour (Dolson 2010).

Effects of aversive conditioning can be limited only to certain contexts, as bears learn to associate negative stimulus with specific situation and fail to generalize negative experience to other contexts. For example, Gillin et al. (1994) reported that bears responded to aversive conditioning only in specific sites (e.g. back-country camps, trailer-truck camps) and had to be conditioned at each of them to achieve avoidance of people in various contexts. Bears also learned to recognize officers by their shotgun, lights on the truck or uniforms, so avoidance of people was achieved only in the presence of officers (Dolson 2010). During aversive conditioning procedures it is therefore important to prevent this context-specific learning, as it can severely limit effectiveness of these measures. For example, to avoid discrimination among public and officers, the latter should not appear different from the general public to the bear.

Another crucial parameter stressed by almost all researchers is availability of anthropogenic food (Gillin et al. 1994; Clark et al. 2002; Herrero 2002; Rauer et al. 2003; Beckmann et al. 2004; Leigh and Chamberlain 2008; Dolson 2010; Mazur 2010; Groff et al. 2013). Failure to prevent access to these food sources can severely limit the effectiveness of aversive conditioning. Therefore any such measures must be paralleled with strict regulations and law enforcement regarding garbage disposal, food storage and bear feeding, as well as public education.

In conclusion, aversive conditioning can be effective tool in certain situations to prevent human-bear conflicts. However, detailed situation-specific planning is required, as well as good understanding of limitations of this tool and factors that may reduce its effectiveness. Bears are highly intelligent and quickly find weaknesses in aversive conditioning measures, so appropriately designed treatments conducted with well-trained personnel is a necessary requirement. Inappropriately designed procedures can quickly lead to habituation to used measures and consequent failure in preventing conflict behaviour (McCarthy and Seavoy 1994; Dolson 2010).

Based on current knowledge, aversive conditioning of bears is most warranted in the following cases:

- when potential conflict behaviour is detected early in the development of a problem bear,
- when short-term solution is needed,
- when adequate resources are available for continuous treatments for each problem bear,
- when possibilities for lethal removal are limited.

TABLE 1: REVIEW OF REPORTED AVERSIVE CONDITIONING TRIALS ON BEARS AND THEIR EFFECTIVENESS (*IN CAPTIVITY; # AVERAGE VALUE).

Species	Region	Methods used	No. of treatments /bear	Short-term effects	Long-term effects	Other observations	Source
<i>Ursus arctos</i>	Europe, Austria	Capture, rubber bullets, warning shots, pyrotechnics	2-7	Variable	Long-term increase in wariness in one female and cubs of another female	Not effective with severely habituated bears	Rauer et al. 2003
<i>Ursus arctos</i>	Europe, Italy, Trentino	Capture, rubber bullets and chasing with dogs	Unknown	Limited short-term effectiveness	Not successful with habituated bears	More effective on young bears	Groff et al. 2013
<i>Ursus arctos</i>	USA, Yellowstone N.P.	Rubber bullets paired with conditioning stimulus (bird call)	1-15	Temporarily effects in some bears; pairing with bird call unsuccessful	Not successful	Less effective with more habituated bears and bears in poor condition	Gillin et al. 1994
<i>Ursus arctos</i> & <i>U. maritimus</i>	Canada, Manitoba*	Loud sounds and repellent chemicals	Unknown	Effective as deterrent	Not effective	-	Miller 1983
<i>Ursus maritimus</i>	Canada, Manitoba	Rubber bullets, loud sound and electric fence used to prevent access to bait sites	1.9#	Rubber bullets effective in deterring bear from the site, 66% returned within a week	Unknown	Rubber bullets most effective in deterring bears when used, electric fence gave mixed results, audio deterrents without effect	Derocher & Miller 1985
<i>Ursus americanus</i>	USA, Nevada	Capture, pepper-spray, rubber bullets, cracker shells, chased by dogs	1	Effective on average for about 1 month	No long-term effect in 92% of treated bears	Longer effects when dogs were used in combination with other methods	Beckmann et al. 2004
<i>Ursus americanus</i>	USA, Great Smoky Mountains N.P.	Capture and on-site release	1	58-73 % success in preventing incidents in the next year	Unknown	Most effective when bears were captured early in their progression toward nuisance behaviour	Clark et al. 2002
<i>Ursus americanus</i>	USA, Louisiana	Capture, rubber bullets and some also chased with dogs	1-2	Limited short-term effectiveness	Successful in 9% of treated bears	Bears conditioned in combination with dogs refrained from nuisance activity slightly longer	Leigh & Chamberlain 2008

Species	Region	Methods used	No. of treatments /bear	Short-term effects	Long-term effects	Other observations	Source
<i>Ursus americanus</i>	USA, New Jersey	Capture, rubber bullets, pyrotechnics and chasing with dogs	1	Effective for max. 17 days	Not effective	Effective for deterring from the capture site for on average 57 days	Huffman et al. 2010
<i>Ursus americanus</i>	USA, Sequoia N.P.	Rubber bullets, rock-throwing, slingshots, pepper spray, chasing (without dogs)	20.3 [#]	Successful in 79% bears	Successful in 59% of bears	Higher success when applied soon after bears obtained human food; less successful on yearlings and strongly habituated bears; rubber bullets and chasing more effective than rock-throwing, slingshots or pepper spray	Mazur 2010
<i>Ursus americanus</i>	USA, Alaska	Rubber bullets	1.8 [#]	Successful in 52% of bears	Successful in 7% of treated bears	Might be more effective where single source of anthropogenic food occur	McCarthy & Seavoy 1994
<i>Ursus americanus</i>	USA, Alaska	Taste aversion using thiabendazol for general anthropogenic food	unknown	Not effective	Not effective	-	McCarthy & Seavoy 1994
<i>Ursus americanus</i>	USA, Minnesota	Taste aversion using thiabendazol for specific food	unknown	Effective for the same type of food	Effective for >1 year, but not for 2 years	Not effective for other types of anthropogenic food	Ternent & Garshelis 1999
<i>Ursus thibetanus</i>	Japan, Hyogo Prefecture	unknown	unknown	Successful in 60%	Unknown	-	Yokoyama et al., 2008; cited in Ohta et al. 2012

1.4.2 MANAGEMENT REMOVALS

1.4.2.1 LETHAL REMOVALS

Lethal removal of bears was a widespread measure used in response to bear incidents in the past (Witmer and Whittaker 2001; Schwartz et al. 2005). Especially when entire bear population is removed, this can be very effective method for preventing conflicts. However, by modern standards such practice became largely unacceptable and for many populations even limited removal can have strong negative effects. Due to low reproduction rates, bears are generally very sensitive to increased human-caused mortality and overharvest is a common concern (McLellan et al. 1999; Swenson et al. 2000; Zedrosser et al. 2001; Bischof et al. 2009). Increasing public intolerance towards killing of charismatic animals in the last decades also often limits use of this measure (Treves and Karanth 2003; Schwartz et al. 2005; Howe et al. 2010).

Lethal removal of bears is most effective, when focused on problem bears. General culling of the population has usually limited effectiveness (Howe et al. 2010; Bereczky et al. 2011). Especially with individuals strongly habituated to human presence or conditioned to anthropogenic food, lethal removal is the most effective short-term solution (Gunther et al. 2004). For such removals it must be ensured that the correct bear is humanely dispatched and these measures must be coupled with effective measures to prevent development of new problem bears (see below), otherwise repeated removals of new problem bears can create a local population sink (Knight et al. 1988) and are not effective for preventing human-bear conflicts in the long-term (Tavss 2005; Dolson 2010). Removing depredating bears was not effective for preventing livestock depredations (Sagor et al. 1997).

It is recommended that any bear that poses an immediate threat to human safety or a bear suffering from life-threatening injuries should be removed. When removing female bears, care must be taken to avoid orphaning cubs (Dolson 2010). In general removal of young, dispersing animals rather than removal of prime, dominant resident individuals is recommended (Ordiz et al. 2013).

1.4.2.2 TRANSLOCATIONS

Translocations of problem bears are generally more acceptable for public than lethal removals (Creachbaum et al. 1998). This measure can sometimes bring temporary good results, but is largely ineffective in a long-term (Herrero 2002). At least for American black bears, translocations were also shown to be less effective for bears conditioned to anthropogenic food (Hopkins and Kalinowski 2013). Beside the drawbacks shared with lethal removal (see above), translocated bears experience high mortality rates, often return to the capture site even from several hundreds of kilometres away, or start causing problems in the new area (Knight et al. 1988; Vaughan et al. 1989; Linnell et al. 1997). Translocations are also costly and labour intensive, and generally large wilderness areas are needed (Linnell et al. 1997; Fontúrbel and Simonetti 2011). Therefore this measure is impracticable for most of the European countries. Interestingly, survey made by Spencer et al. (2007) showed that many of the North American

bear management agencies are still frequently using translocations despite majority of them is aware of low effectiveness of this measure.

1.4.3 DIVERSIONARY AND SUPPLEMENTARY FEEDING OF BEARS

In many parts of the world, feeding of wild bears is illegal, but some countries still practice this measure, also as a conflict prevention strategy (Kavčič et al. 2013). By providing food in remote areas, managers attempt to divert bears from approaching settlements and/or reduce damage to human property (Kaczensky 1999; Huber et al. 2008; Kavčič et al. 2011). Beliefs among experts about the effectiveness of such diversionary feeding for conflict mitigation are contrasting: some believe it can reduce conflicts (Rogers 2011), while others argue it increases them (Herrero 2002; Gray et al. 2004). Direct studies in Europe have indicated low effectiveness of diversionary feeding as a conflict prevention measure (Jerina et al. 2011; Kavčič et al. 2013; Kavčič et al. 2014; Steyaert et al. 2014). On the other hand, experiments with American black bear have shown that seasonal supplemental feeding of bears can reduce damage in forestry (Ziegltrum 2004), although some authors was concerned about side-effects, such as increased carrying capacity (Creachbaum et al. 1998; Kavčič et al. 2014). There is also a growing concern among experts worldwide for other potential negative side-effects of bear feeding (Herrero 2002; Penteriani et al. 2010; Jerina et al. 2013; Kavčič et al. 2013; Kavčič et al. 2014; Selva et al. 2014).

1.4.4 LIMITING ACCESS TO ANTHROPOGENIC FOOD AND PUBLIC EDUCATION

Anthropogenic food available to bears is often the most important cause for occurrence of human-bear conflicts. Therefore it is not surprising that limiting access to these food sources is regarded as the most effective way to prevent many of the human-bear conflicts. In this way, bears are not rewarded anymore for approaching humans or developed areas and consequently habituation to human presence and food-conditioning are considerably less likely (Knight et al. 1988; Herrero 2002; Herrero et al. 2005).

There are numerous approaches how to effectively prevent bears from accessing anthropogenic food sources (for review see Sowka 2009). Bear-proof containers prevent bears to use garbage, while at the same time enable easy access to people. Suitable electric fences and other electric-shocking devices are generally highly effective to deter bears from bee-hives, orchards, bird feeders and other human property. Electric fences can be used also as night enclosures to protect livestock. In similar way stables and barns can be used for night protection. Protection of livestock can be further increased with the use of livestock guarding dogs and/or shepherds. Special attention is needed for regulation of direct bear feeding by people, as this is the fastest way leading into development of a problem bear. Strict legislation and its enforcement with fast response are crucial, as well as accompanying public education. People tend to follow prescribed rules more, when they understand reasons behind them (Creachbaum et al. 1998; Witmer and Whittaker 2001; WSPA 2009; Dolson 2010). Experiences also suggest that this approach gives better success when local communities and individual inhabitants are actively involved in the

efforts to prevent bears from accessing anthropogenic food (Primm and Wilson 2004; Treves et al. 2006; WSPA 2009).

Generally these measures are less affective once bears have already become food-conditioned and habituated to human presence. In such cases much more efforts are needed to prevent access to anthropogenic food, as these bears can overcome obstacles and deterrents that would prevent access to most non-problem bears. Once problem bears are already developed, measures for preventing access to human foods should be used simultaneously with aversive conditioning or management removal of bears.

First systematic measures targeting availability of human food sources were applied in the 1970s and 1980s in North American national parks following high rates of human-bear conflicts, including several human casualties (Herrero 1994). Strict garbage management, regulations on human food storage, prohibition of bear feeding and intensive public education about proper behaviour in bear habitat proved very successful. After application of these measures, human-bear conflicts throughout national parks decreased considerably. For example, in Yellowstone National Park, attacks on people dropped for almost 90% and at the same time there was less need for management removals of bears (Meagher and Phillips 1983; Gunther and Hoekstra 1998). In Denali National park, cases of bears feeding on anthropogenic food decreased for 96%, which was followed by 77% drop in reported human-bear conflicts and 77% lower number of management removals (Schirokauer and Boyd 1998). Similarly, after the change of focus from bear management to management of people and anthropogenic food, number of problem bears removed decreased for 94% for black and 86% for brown bears in Jasper National Park (Ralf 1995), and for 75% for black and 70% for brown bears in Glacier National Park (Gniadek and Kendall 1998). In Yosemite National Park after management was changed from reactive (lethal removals, translocations, aversive conditioning) to proactive (limiting access to anthropogenic food, education, law enforcement) the proportion of anthropogenic food and garbage in black bear diet was reduced for 63% and the number of bear incidents decreased for 31% and amount of damage caused by bears for 63% (Madison 2008; Greenleaf et al. 2009; Hopkins et al. 2012; Hopkins et al. 2014).

Limiting availability of anthropogenic food for bears is generally easier to solve in national parks than in residential areas, where changes in rules regarding human behaviour and garbage management are often political decision (McCarthy and Seavoy 1994). However, also in residential areas considerable improvements can be achieved with public education and preventing access to anthropogenic food, when correct approach is used. For example, in Western Montana (USA) after proactive project was launched with free removal of livestock carcasses for ranchers, introduction of bear-proof garbage bins, intensive public education and involvement of local communities, as well as donations of electric fences for beehives, cattle calving areas and garbage dumps, number of conflicts with brown bears decreased for 91% in three years without removal of a single bear (Wilson et al. 2006; Wilson 2007). Substantial decrease in human-bear conflicts and management removals of brown bears was noted also in Kennecott Valley (Alaska, USA) after local residents were provided with bear-proof garbage

containers, electric fences and targeted public education (Wilder et al. 2007). Similar successes (40-80% reduction) in reducing human-bear conflicts by preventing bear feeding on human food sources were reported also for the American black bears in residential areas across USA (Tavss 2005; Leigh and Chamberlain 2008). Successful prevention of human-bear conflicts by limiting access to anthropogenic food was also reported for other ursids, such as Asiatic black bears (*Ursus thibetanus*) (Huygens and Hayashi 1999) and sun bears (*Helarctos malayanus*) (Fredriksson 2005).

Preventing access to anthropogenic food and public education have so far received less attention in Europe, although also here local initiatives have given good results (e.g. in Trentino; Groff et al. 2013) and despite the fact that these measures are prescribed in the Action Plan for the conservation of the brown bear in Europe (Swenson et al. 2000).

1.4.5 BEAR SPRAY

Red pepper spray-based repellents are regularly used to deter bears from attacking, especially in North America. Tests in captivity and in the wild have proved their effectiveness. Use of spray in encounters with wild bears stopped bears' undesirable behaviour in 92% of the time and human injuries were prevented in 98% of close-range encounters with bears (Smith et al. 2008). In addition to actual prevention of bear attacks, use of bear spray have psychological effect and may be important to prevent exaggerated irrational fear of bears. On the other hand, relying on bear spray may cause people to act recklessly, similar to when carrying firearms (Herrero 2002).

1.1.2 LAND-USE PRACTICES

There are several potential mechanisms how land-use practices can affect probability for occurrence of human-bear conflicts. For example, increasing human encroachment into historic bear habitat has significantly contributed to the escalation of human-bear conflicts due to the loss of natural food items and the increasing presence of refuse generated by humans (Rogers et al. 1976; Leigh and Chamberlain 2008). Limiting certain human activities or general human access to most crucial bear habitats in certain time periods gave positive results in American national by allowing unhindered foraging opportunities for bears, decreasing the risk of habituation, and providing safety for hikers (Coleman et al. 2013). Since cover is important parameter affecting space use by bears, maintaining open habitats in the vicinity of human settlements could deter bears from approaching settlements and thus limit opportunities for habituation and occurrence of bear incidents (Krofel and Jerina 2012a). Some authors therefore recommend removing dense vegetation near crops (Sato et al. 2005) and around human settlements, especially in remote areas with dominant bears, which often prefer low human disturbance (Elfström et al. 2014a,c).

Transition from sheep to cattle or horse breeding, from livestock breeding to other land use (e.g. agriculture, forestry), or selection of crops less attractive to bears can reduce probability of bear damage (Sagor et al. 1997; Mattson 1998; Witmer and Whittaker 2001; Zimmermann et al.

2003; Gunther et al. 2004; Swenson and Andren 2005; Wilson et al. 2006). However, generating a will for such changes among stakeholders is often a considerable challenge (Linnell et al. 2013).

1.4.6 COMPENSATIONS

Damage caused by wildlife is generally distributed unequally across society. Compensations paid for damage caused by wildlife can redress these inequities and can at the same time be effective measure to increase tolerance towards protected species and limit poaching (Treves et al. 2009). However, when tested, these effects have often not been detected (Naughton-Treves et al. 2003; Treves et al. 2009; Boitani et al. 2010). In general, several authors warn that compensations must be used with care, as poorly planned compensations systems can achieve opposite effect – promoting higher conflict rates and discouraging effective conflict prevention measures, as well as enable fraud (Bulte and Rondeau 2005; Zabel and Holm-Muller 2008). When compensations act only as additional subsidies, they can promote maintaining feeling of permanent conflict, as receivers of compensations are afraid of losing financial income (Cozza et al. 1996; Boitani and Ciucci 2009). It must also be understood that paying compensations does not affect occurrence of bear incidents, therefore other measures must always be used in parallel (WSPA 2009). Some authors suggest that more effect can be achieved by paying for prevention measures or rewarding owners without damages (Bulte and Rondeau 2005). It also appears that compensations are more sensible for short-term in small, threatened and recovering populations, then in a long-term after populations have already recovered (Treves et al. 2009). Another suitable application of compensations is when alternative (natural) prey for predators is lacking and preventing livestock depredations could threaten the population (Breitenmoser et al. 2005).

TABLE 2: OVERVIEW OF MAIN TYPES OF HUMAN-BEAR CONFLICTS AND MOST EFFECTIVE MEASURES TO MITIGATE THEM ACCORDING TO THE EXPERIENCES REPORTED SO FAR. UNDERLINED ARE MEASURES USED TO PREVENT CONFLICTS BEFORE THEY OCCUR.

CONFLICT TYPE	MAIN MEASURES FOR CONFLICT PREVENTION
Livestock depredations	<ul style="list-style-type: none"> - <u>protection of livestock using electric fences and/or livestock guarding dogs</u> - <u>night enclosures for livestock</u> - removal of the problem bear - <u>transition to species less vulnerable to bear attacks</u>
Damage on beehives, crops, orchards and other human property	<ul style="list-style-type: none"> - <u>protection of property using electric fences</u> - removal of the problem bear - aversive conditioning - <u>removing dense vegetation (cover for bears)</u>
Damage in forestry	<ul style="list-style-type: none"> - <u>supplemental feeding</u>
Bear occurrence near human settlements	<ul style="list-style-type: none"> - <u>preventing bear access to anthropogenic food</u> - removal of the problem bear - <u>education of local inhabitants</u> - aversive conditioning - <u>removing dense vegetation (cover for bears)</u>
Attacks on humans	<ul style="list-style-type: none"> - removal of bear exhibiting aggressive behaviour towards people - <u>public education</u> - <u>decreasing bear habituation to humans and food conditioning (e.g. through preventing access to anthropogenic food and aversive conditioning)</u> - use of bear spray - <u>temporary limiting public access to most critical bear habitats and bear dens</u>
Vehicle collisions	<ul style="list-style-type: none"> - <u>appropriate planning when constructing transportation network</u> - construction of safe under- or over-passes for bears in combination with electric fences - <u>removing or preventing access to attractants (e.g. garbage bins) near roads and railways</u> - <u>measures used to prevent bear habituation to humans</u>

OVERVIEW OF EUROPEAN MANAGEMENT FRAMEWORKS

Bear experts and managers from 15 different European countries provided information on how their national management plans define **habituated and food conditioned** bears and what are the management approaches used in dealing with habituated and food conditioned bears.

Terms “habituated” and/or “human food conditioned” bears are very rarely used in the official management documents. Most often a term that would roughly translate to “**problem bear**” is used to describe a habituated or food conditioned bear, but in some countries this includes practically any conflict-causing bear behaviour (i.e. not related to repetitive behaviour). A range of **problematic bear behaviours** is usually described, and proposed management measures are linked to those behaviours.

How and when a bear is considered to be a problem bear varies considerably between the countries. The “diagnostic tools” range from **simple definitions** (e.g. a bear that is repeatedly approaching anthropogenic food sources) and individual **ad hoc expert assessments** to **complex classification systems** used for risk assessment. Overall, countries with smaller (more endangered) populations tend to have more complex and better defined risk assessment protocols which include management recommendations.

Although the overview of the theoretical background would suggest that preventive proactive measures should be a priority, European brown bear management plans mostly deal with **reactive management**. The documents provide variable level of detail, but generally foresee following management measures: close monitoring, aversive conditioning, removal or fencing of the attractant, removal of individual animals (lethal or translocations to nature/captivity), compensations for the damages, information campaigns. Sometimes special emergency teams are formed which are in charge for implementation of urgent actions regarding problem bear management. **Proactive management** aimed at preventing occurrence of problem bears is often related to implementation of individual projects and in most cases it is not systematically organized. Such measures include: prevention of damages to agriculture, prevention of access to organic waste, enhancing the trophic value of bear habitat (i.e. feeding of bears at feeding stations, planting of wild fruit trees), information campaigns to influence problematic human behaviour (intentional or unintentional feeding or disturbing of bears), dialogue with stakeholders, emergency teams, green bridges and specific road signs, abandoning the practice of rehabilitation of orphaned bears.

Considering the diversity of management approaches it is evident that **public perception** plays a considerable role both in identifying a “problem bear” and in selection of the appropriate reactive management measures.

1.5 COUNTRY SUMMARIES

1.5.1 AUSTRIA	
Estimated population size ¹	~ 5
Contributor	Georg Rauer and Felix Knauer
The description of the habituated and/or food conditioned bears in the official national documents	<p>The definition in the management plan is: “A bear that poses an imminent risk to people has lost its fear of humans searching for food in the vicinity of humans. There is an increased risk that such an individual behaves aggressively towards humans.” There are tables with more details on how to evaluate bear behaviour.</p> <p>Additionally, in the protocol of the bear JJ1 case we defined different bear behaviours more explicitly. These definitions will be used in the future when bear advocates and experts advise responsible authorities on handling of habituated and/or food conditioned bears.</p>
Management approaches for dealing with habituated and/or food conditioned bears	A detailed risk assessment protocol with management recommendations prepared based on the following reasoning: (1) bears in Austria are a critically endangered species, (2) a co-existence of bears and humans only will work, if the risk of seriously injured or killed persons by bears will be minimized, and (3) the focus will be on individuals and therefore cost-effectiveness plays a minor role (cost-effectiveness in the sense of effort on the change of the behaviour of problematic bears in comparison to the negative effect on population viability by removing a single bear).
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	Damage prevention and information not to feed bears intentionally or unintentionally (e.g. for hunters running roe deer feeding stations, garbage management at alpine huts); there is no proactive program;

¹ Estimated population sizes for all countries are taken from the Kaczensky et al. (2012) Status, management and distribution of large carnivores – bear, lynx, wolf and wolverine – in Europe. Report prepared under contract No070307/2012/629085/SER/B3. Downloaded from: http://www1.nina.no/lcie_new/pdf/635010989491744309_2013_03_25_Updated%20status%20of%20LC%20in%20Europe_Part2.pdf

1.5.2 BULGARIA	
Estimated population size	530-590
Contributor	Diana Zlatanova
The description of the habituated and/or food conditioned bears in the official national documents	There are two documents defining habituated bears - the Action plan for the Brown bear in Bulgaria, 2008 and the "Program for decreasing the bear damages in Smolyan region (Rhodopi Mountain)", which has the largest share of the damages in Bulgaria. In these documents a detailed description of all kinds of problematic bear behaviours are given and in the second document, a detailed description of preventive and proactive measures is given with timeframe and necessary budget included.
Management approaches for dealing with habituated and/or food conditioned bears	Depending of the type of behaviour, the management plan prescribes different measures which include close monitoring, aversive conditioning and removal of animal. An emergency team has been established.
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	Electric fences, limiting access to garbage dumps, bear-proof garbage containers, local hunting quota in some cases.

1.5.3 CROATIA	
Estimated population size	~1000
Contributor	Djuro Huber
The description of the habituated and/or food conditioned bears in the official national documents	The bear that is repeatedly approaching anthropogenic food sources.
Management approaches for dealing with habituated and/or food conditioned bears	<ul style="list-style-type: none"> a) Local hunters, local mayor or somebody else warns about habituated bear – calls the regionally responsible Bear Emergency team (BET) member or writes to the hunting service in the Ministry for Agriculture b) BET person inspects the situation and reports to the Bear management committee c) BET person advises locals to remove the attractant(s) d) BET person or local hunters get rubber bullets to apply aversive conditioning to the bear e) If the applied measures do not solve the problem, the BET person propose the intervention shooting of the bear f) Bear management committee decides and the deputy minister signs the intervention shooting document g) BET person takes measures to ensure that the proper bear is shot h) If shooting takes place in urban area, zoo local police is present i) BET person with local hunters takes measurements, samples and makes the report j) If the bear is not shot within 2 weeks, the permit expires
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	Removal or fencing of the attractant (usually cannot be done), chasing by rubber bullets, intervention shooting.

1.5.4 ESTONIA	
Estimated population size	~700
Contributor	Peep Männil
The description of the habituated and/or food conditioned bears in the official national documents	There are no definitions of habituated bears in official documents.
Management approaches for dealing with habituated and/or food conditioned bears	There were no such cases in Estonia in recent years. In the past, there were some cases with rehabilitated bears only and those individuals were eliminated by state staff.
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	Abandoning the practice of rehabilitation of orphaned bears. Probably regular hunting also helps to avoid the occurrence of such bears as habituated bears are less shy and are more easily hunted.

1.5.5 FRANCE	
Estimated population size	~25 (minimum detected in 2013)
Contributor	Jean Jacques Camarra
The description of the habituated and/or food conditioned bears in the official national documents	<p>There is no detailed definition of habituated and/or food conditioned bear in France. This situation is included in our protocol in a more general way: a bear too familiar with humans.</p> <p>The French problem bear protocol describes the strategies that could be adopted in three cases: 1. bear familiar with humans, 2. exceptionally high predation level of a single bear on well protected livestock , 3. aggressive behaviour towards humans.</p>
Management approaches for dealing with habituated and/or food conditioned bears	<p>Except one subadult bear (only sometimes tolerant to people) detected in 1992, no habituated and/or food conditioned bears were registered in the Pyrenees.</p> <p>However there is a protocol in place according to which five stages have to be respected: 1. identification of the bear, 2. implementation of preventive measures, 3. attempt aversive conditioning, 4. trap and equip the bear with telemetry device, 5. elimination of the animal. The points 2-3 are well detailed because the main goal is to change the behaviour, before the lethal removal.</p>
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	<p>There is no specific strategy on management of garbage sites and other food sources related to humans (except domestic cattle). In France, in mountain areas, deposits of garbage and dead animals are forbidden.</p> <p>In the core bear area, efforts are made together with the shepherds to implement three main measures to reduce the conflicts between bears and livestock: 1.presence of the shepherd at the cabin, 2. flock the livestock every night around the cabin, 3.protection dog (Pyrenean dog).</p> <p>When we detect a high predation level due to one particular bear, we try to optimize the prevention with the shepherds (set electric fences, dogs, human presence). If this is not sufficient, we apply aversive conditioning techniques (rubber bullets, fireworks) to try to repel the bears from the vicinity of the sheep flock, and so, try aversive conditioning.</p>

1.5.6 GERMANY - BAVARIA	
Estimated population size	-
Contributor	Manfred Wölfl and Jochen Grab
The description of the habituated and/or food conditioned bears in the official national documents	<p>Bavarian Bear Management plan includes following definitions:</p> <p>Food conditioned: linkage of human presence/houses with easily available food.</p> <p>Habituated: no or less shyness towards humans.</p>
Management approaches for dealing with habituated and/or food conditioned bears	<p>Intensive monitoring: to detect behavioural traits mentioned above</p> <p>Aversive conditioning: special team to apply deterrence measures</p> <p>Removal of animal: by special team</p>
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	Up to now no specific action has been taken. Possible pilot regimes are being discussed in the frame of so called “prevention funds”.

1.5.7 GREECE	
Estimated population size	350-400
Contributor	Yorgos Mertzanis
The description of the habituated and/or food conditioned bears in the official national documents	<p>“Management Protocol for cases of human-bear interactions” defines »problem bears« as follows: it concerns bear individuals which behaviourally speaking have overpassed the threshold of familiarization and tolerance of human presence and human activities and have become almost completely dependent on anthropogenic food resources and thus exhibiting a behaviour that comprises daily presence close or inside human settlements and urban areas. An official “Protocol for bear-human interactions management” has been adopted by the National Authorities and has become national law (FEK272/07-02-2014) in February 2014.</p>
Management approaches for dealing with habituated and/or food conditioned bears	<p>The used management approaches comprise different levels and practices depending on the level and degree of the problem and the “individual” of each bear involved according to the official operational protocol. A specific protocol in a form of a scoring chart has been elaborated and adapted for this purpose. Depending on the bear behaviour, the protocol foresees different measures ranging from monitoring and aversive conditioning, management of attractants and also non-lethal removal of bears.</p>
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	<ul style="list-style-type: none"> - Use (at a pilot scale) of bear proof garbage bins. - Occasional relocation/translocation of females with cubs (already exhibiting habituated behaviour). - Use (at a wider scale) of other bear deterring/preventive measures such as electric fencing and livestock guarding dogs. - Planting of wild fruit trees (orchards) in bear forest habitat in order to enhance trophic value of core bear habitat and dissuade bears from easily approaching human settlements. - Information campaigns (e.g. printed materials)

1.5.8 ITALY - ITALIAN CENTRAL-EASTERN ALPS	
Estimated population size	33-36
Contributor	Claudio Groff, Elisabetta Rossi, Elena Tironi and Piero Genovesi
The description of the habituated and/or food conditioned bears in the official national documents	<p>Action plan (PACOBACE) defines a problem bear as bear that causes damage or nuisance bear or a bear that is problematic according to its behaviour.</p> <p>A bear that causes damage is a bear that repeatedly causes material damage (predation on domestic livestock, destruction or damage to crops or hives, or damage to infrastructure in general) or uses repeatedly anthropogenic food sources (food for humans, livestock feed or for foraging wildlife, waste, fruit grown in the vicinity of dwellings, etc.). A bear that causes only one severe damage (or which causes damage only very rarely) is not considered a nuisance bear.</p> <p>Dangerous bear - there are a number of behaviours that leave the possibility that a bear could be a source of danger to humans. Except in exceptional circumstances, a bear that exhibits avoidance behaviour, typical for the species is not dangerous and tends to avoid encounters with humans. The dangerousness of an individual is usually directly proportional to its "habituation" to people and the level of confidence with humans. In other cases dangerousness is regardless of habituation to human presence and is instead related to specific situations, such as when a female bear with cubs is approached or when a bear is defending its prey. PACOBACE provides an explicit table to describe dangerous behaviours, and the management approaches that can be applied for each behaviour.</p>
Management approaches for dealing with habituated and/or food conditioned bears	<ul style="list-style-type: none"> - Damage prevention: electric fences (e.g. almost one thousand distributed in last 12 years), guarding dogs - Damage compensations: 100% of the value, within 30-40 days - Bear proof garbage bins: around 140 distributed - Aversive conditioning: rubber bullets, bear dogs (4), firecrackers, sound deterrents - "Hard release" after captures (rubber bullets and dogs, together) - Intensification of monitoring (in the case of a bear with radio collar) - Information for the owners and/or guardians of domestic livestock; for the owners and/or habitual users of isolated mountain huts; for people possibly using the area (tourists, mushroom pickers etc.) - Overnight stabling of sheep, goats and cattle and other protection measures - Rapid removal of dead animals in alpine pasture

	<ul style="list-style-type: none"> - Careful management of organic waste, with possible adaptation of containers and dumps - Setting up of structures suitable for preventing damage caused by bears (electric fences) - Setting up of a defence watch, in case of recorded bear presence - Emergency team in the area - Capture for permanent captivity - Killing of the animal (never applied so far)
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	<ul style="list-style-type: none"> - Damage prevention - Garbage management - Aversive conditioning - Public education (meetings, conferences, website, leaflets, posters, reports, schools programs, TV, radio, newspapers) - Information for the owners and/or guardians of domestic livestock; for the owners and/or habitual users of isolated mountain huts; for people possibly using the area (tourists, mushroom pickers etc.) - Overnight stabling of sheep, goats and cattle and other protection measures - Rapid removal of dead animals in alpine pasture - Careful management of organic waste, with possible adaptation of containers and dumps - Setting up of structures suitable for preventing damage caused by bears (electric fences) - Round table with stakeholders established - Improving shepherds conditions on alpine pastures i.e. providing box-shelters close to livestock - Emergency team 24h active, established in 2003 - Specific road signs to prevent car-bears accidents

1.5.9 POLAND	
Estimated population size	~80
Contributor	Agnieszka Sergiel, Nuria Selva, Tomasz Zwijacz-Kozica
The description of the habituated and/or food conditioned bears in the official national documents	Proposed national bear management plan provides detailed descriptions of habituation and food-conditioning in the context of learning processes that alter bear behaviour, thus making bear problematic. It proposes use of term “problem bear” instead of “synanthropes” .
Management approaches for dealing with habituated and/or food conditioned bears	<p>The lack of an effective system of collecting the information about such cases in this area may prevent a proper assessment of the real situation in the Bieszczady region. Most bears in Bieszczady are strongly conditioned by supplemental food provided for game, and their movements seem also to be influenced by the location of the feeding sites. Intentional luring and feeding of bears, also with wastes of human food and leftovers from slaughterhouses, aiming to create a local tourist attraction, or to help in photo and video recording, is becoming more and more popular in Bieszczady.</p> <p>In Tatra Mountains, habituated and more often food conditioned bears appear almost every year since the 80s. The appearance of problem bears in this area was mainly due intentional feeding. The magnitude of this problem has been significantly reduced since proper waste management, deterrence and aversive conditioning of bears have been implemented systematically during the last decade of last century. Even if now there are no records of problem bears, electric fences are used to protect most of buildings, and sheep flocks inside the Tatra National Park and at its close vicinity. If problem bear appears, aversive conditioning is implemented (shooting with rubber bullets) and the situation is closely monitored.</p>
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	<p>Following actions are recommended in the draft of the management plan for Poland:</p> <ul style="list-style-type: none"> • Detailed documentation of any events involving problem bears. • Creation of Bear Emergency Team. • Deterrence. • Stop promoting artificial feeding of bears. • Feeding of bears only with special permission of competent authorities. • Removal of garbage bins along hiking trails.

	<ul style="list-style-type: none"> • Replacement of garbage bins with bear-proof ones. • Information and education campaigns.
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1.5.10 ROMANIA	
Estimated population size	~6000
Contributor	Silviu Chiriac
The description of the habituated and/or food conditioned bears in the official national documents	<p>The Romanian legislation has no definition of habituated or food conditioned bears. An older (2006) document considered to be the brown bear management plan for Romania, even if it was not approved officially is defining</p> <ul style="list-style-type: none"> • the habituated bears as : "On such sites bears start associating the smell of humans with a positive experience, this being the opposite from experiences they had before. A bear with such experiences might not try to avoid humans, or may even become habituated to humans." and "Habituated bears, bears that lost their fear of humans,...." and ".... bears that gradually lost they ancestral fear of humans." • the food conditioned bears as: no definition <p>In the framework of the LIFE08NAT/RO/000500 LIFEURSUS project a guide to assess the risk represented by the presence of bears close to human habituated areas was elaborated. The guide was approved by the Ministry as a tool for the local organization dealing with bears. In the guide following definitions are used:</p> <ul style="list-style-type: none"> • the habituated bears as : A new image, sound or noise is usually attracting the animal's attention and the animal is responding in some way. If the stimulus is present repeatedly without positive or negative consequences, the animal gets used with the stimulus and the attention and the responses are useless. The animal has become familiarised with the stimulus. If a bear is meeting regularly humans without getting food from them and is not injured by them, it will start to tolerate them at smaller distances than before and occasionally it will ignore them. This bear is used to humans, habituated (adapted after <i>Stephen Herrero Bear attacks. Their causes and avoidance. The Lyons Press, Revised edition 2002</i>). • the food conditioned bears as: A habituated bear that eats human food and waste, is behaving differently comparing with a bear that is just habituated. Such a bear has made the simple association and is linking humans with food. A bear manifesting this expectation is considered to be a food conditioned bear (adapted after <i>Stephen Herrero Bear attacks. Their causes and avoidance. The Lyons Press, Revised edition 2002</i>).

Management approaches for dealing with habituated and/or food conditioned bears	<p>Historical there were three approaches used:</p> <ul style="list-style-type: none"> -do nothing -capture and relocate a problem bear -shooting the/a bear (not always the right one) <p>There were no standard approaches and the management was in 100% of the cases reactive. No decision was taken until the problem is important enough. The shooting of bears was the most used tool before 1990. Increased financial interest on bear trophy made the choice of shooting a problem bear a difficult decision. Later (around year 2000) the animal welfare organization requested different approaches and translocation became a new and fancy tool, but not always a successful one.</p> <p>Since 2010 in the framework of the LIFE08NAT/RO/000500 LIFEURSUS project implementation of best practices of dealing with habituated and food conditioned bears from other countries were introduced, including the first preventive measures, but still mostly as a reactive management. The guidelines mentioned above describe the most suitable solutions at different level of intervention for the most frequent human-bear conflicts.</p>
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	<p>For the food conditioned bears (in most of the cases garbage bears) one of the effective measure was the implementation of the EU regulation related to waste management. The improvement of the waste management system has reduced the hotspot areas with garbage bears. Applied also independently in some pilot areas like Braşov, Tuşnad this was the most effective tool for human- bear conflict.</p> <p>Supplementary feeding is considered by the hunters to be a management tool for keeping bears in the forest and to keep them out from villages. Unfortunately there are no studies made in Romania to confirm the impact of this measure.</p>

1.5.11 SLOVAKIA	
Estimated population size	800-1100
Contributor	Robin Rigg, Michal Haring
The description of the habituated and/or food conditioned bears in the official national documents	There is no specific reference to habituated or food conditioned bears in the official documents (there is no management plan).
Management approaches for dealing with habituated and/or food conditioned bears	Since there is no management plan, clear protocols are lacking. Occurrence of conflict situations is dealt with in an ad hoc manner. Most common is removal (both lethal and non-lethal) of the bear.
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	Bear-proof garbage bins, electric fencing, dogs are occasionally implemented by NGOs, some protected area staff and some private persons.

1.5.12 SLOVENIA	
Estimated population size	~440
Contributor	Marko Jonožovič
The description of the habituated and/or food conditioned bears in the official national documents	<p>In Slovenia, two documents describe the notion “habituated and/or food conditioned bears” in a more plastic and indirect way:</p> <ol style="list-style-type: none"> 1. Brown bear Management Strategy (adopted in 2002 by the Government of Slovenia), page 18, where the text defines the management removal of bears as a tool used in case when: Exceptional shooting of bears is carried out in cases where bears directly threaten humans, that is, when they attack humans, when they remain for longer periods in the direct vicinity of human dwellings or in cases where they attack domestic animals. A view on the necessity for exceptional shooting is given by the authorised professional public institute. Exceptional shooting is possible at any place and time, irrespective of weight structure. In the event of management removal of a female bear with young, it is always the young that are shot first and only then the mother. The removal is performed by a state authorised professionally qualified organisation or emergency team. Exceptional shooting is performed in a legally provided manner. If an exceptional shooting has been carried out in self-defence, in other words in a case of actual attack by a bear on a human, the state authorised professional public institute gives an opinion on this. 2. Minister’s “Decision on establishing and functioning of Brown bear Intervention Group in Slovenia” (issued in 2006) when the group is activated in cases, when on the call of Emergency Center (Number 112) or the Police (number 113) bear poses threat to humans, like: <ul style="list-style-type: none"> • Direct encounter with humans; • Attack on livestock or any other human property; • Vehicle collision, when the bear is wounded and not found dead on the scene; • Entrance of bear inside of village or group of human settlements; • Bear appearance in the inside or in the vicinity of human settlements, in the vicinity of farmers logistic objects (barns, stables...), fenced areas for livestock breeding or infrastructure objects like roads and paths and dumps.

<p>Management approaches for dealing with habituated and/or food conditioned bears</p>	<p>Commonly used approach is the call from 112 and 113 to the responsible persons of the Bear Intervention Group and then their response, defined in the Ministers' Decision, like:</p> <ul style="list-style-type: none"> • Call response with some persons involved in case of bear threat; • Deterrence of the animal; • Capture of the animal and relocation to another remote suitable area; • Stalking of wounded animal with blood tracking dog; • Shooting of the animal; • Other means and tools available in concrete situation. <p>By each case, according to the concrete circumstances, Slovenia Forest Service where the Bear Intervention Group is established decides which tool will be used. The decision of shooting a bear is not easy, but since the population is vital (450-550 animals; high density) and exceptional removal is a part of yearly culling quota, we decide in many cases to shoot such a bear causing troubles and preserve on another hand less problematic bear.</p> <p>On the other hand capturing, tranquilisation and relocation of trouble causing bears is publically desirable but in limited area like Slovenia it is also completely non-effective tool. Till nowadays we captured and translocated more than 30 bears of different age and sex and more than 90 % came back to the "hot spot" in less than a week, causing the same kind of trouble.</p>
<p>Management approaches for prevention of occurrence of habituated and/or food conditioned bears</p>	<p>Commonly used management approaches are regular informing of the broader public and especially local population through public releases, leaflets, posters, stickers, lectures at schools and local communities, media interviews where we inform people on bear ecology, behaviour and proper human response in some situations.</p>

1.5.13 SPAIN	
Estimated population size	217-237
Contributor	Juan Carlos Blanco
The description of the habituated and/or food conditioned bears in the official national documents	There is no specific reference to habituated or food conditioned bears in the official documents. A draft protocol about habituated and problem bears, including definitions and management options is under discussion.
Management approaches for dealing with habituated and/or food conditioned bears	There are no typical habituated bears but only few cases of young bears feeding on orchards close to villages. Since habituated bears are so rare there are no common approaches to deal with them.
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	There are no common approaches to prevent the occurrence.

1.5.14 SWEDEN	
Estimated population size	~3300
Contributor	Marcus Elfström
The description of the habituated and/or food conditioned bears in the official national documents	<p>There are no official guidelines defining habituated or food-conditioned bears in Sweden, regarding national or regional management plans or other official documents.</p> <p>The management of problem bears is carried out on a regional level by the County Administrative Boards (CAB), and their view of habituated and food-conditioned bears may differ among the counties. Regional management plans designed by the CAB usually state that 'unwary' bears may be scared away using dogs, while potential food attractants are advised to be removed or can be assisted to be removed by the manager, and if the bear returns it may be destroyed. Bears may be viewed as habituated/food-conditioned, or at risk of becoming so, on an individual basis. Nevertheless, there is no official definition of what constitutes a habituated/food-conditioned bear.</p>
Management approaches for dealing with habituated and/or food conditioned bears	<p>Lethal removal of individual bears which are considered to be problematic near settlements is assumed to have no effects on the population viability or bear conservation.</p> <p>The most common situation when bear(s) are observed near rural settlements usually involves individual(s) grazing on open pastures while being close enough for people to observe them. Most observations of bears near settlements occur during the spring/early summer. The management is concerned that bears near people or human settlements are human habituated or food-conditioned, or that the animal may learn to become so, and that such individuals may be dangerous. Therefore, provided that anyone reports observations of bear(s) near people to the police or CAB, the bear(s) may be immediately chased away using armed personnel with dogs (usually by certified 'emergency teams'), alternatively no action will be taken but communication with people. Followed by one or repeated harassments of the bear(s) if it returns near areas with high human activity, the individual(s) can be destroyed due to human safety.</p>
Management approaches for prevention of	When bears have been observed near or inside settlements, the managers advise the local residents to remove any food attractants, and may also assist in this removal, in order to reduce the risk of food conditioning to occur

occurrence of habituated and/or food conditioned bears	among bears. Besides chasing away bears using dogs, the management (CAB) is subsidising the use of electrified fences, in order to encourage preventive measures by the public to reduce the accessibility to food attractants including livestock.
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1.5.15 SWITZERLAND	
Estimated population size	up to 2 male individuals
Contributor	Reinhard Schnidrig
The description of the habituated and/or food conditioned bears in the official national documents	Problem bear is defined in the bear management plan as a bear showing no fear of humans (e.g. largely reduced flight distance), diurnally active in areas with high human presence, conditioned to food from human sources, being known as causing above-average economic damage in close vicinity or within villages.
Management approaches for dealing with habituated and/or food conditioned bears	A problem bear will be captured and radio-tagged at a very early stage. Afterwards, aversive conditioning measures will be applied at every chance when the bear approaches human settlements (measures are: shooting with rubber bullets, shooting with rubber bullets, shooting in the air, noise, dogs chasing the bear). A bear closely pursuing and/or attacking people or a bear with a high risk of injuring a human (e.g. a bear searching repeatedly food in densely settled areas with no positive answer to the adverse conditioning measures) will be shot.
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	In a valley where a bear presence is confirmed, people will be informed about bear-behaviour, livestock and bee-hives will be protected, all possible food sources close to or within human settlements will be looked for and removed wherever possible.

RISK ASSESSMENT PROTOCOL AND MANAGEMENT RECOMMENDATIONS

European brown bear experts and managers were brought together in two workshops to discuss and develop a general approach to risk assessment regarding brown bear behaviours which can pose threat to human safety. Below is the final output, organized as a risk assessment protocol based on the assessment of the individual bear behaviour. The protocol indicates the degree of problem and urgency of the action in three categories indicated with green (least problematic, not urgent), yellow and red (most problematic, urgent reaction needed) colours. For each of the listed bear behaviours recommended management action(s) is listed. Additional recommendations for specific bear categories are listed below in separate paragraphs.

Degree of problem and urgency of action	Individual bear behaviour	Recommended management actions	Recommended public communication actions
	a bear unaware of human presence is continuing its natural behaviour	no action towards the bear	Provide information on bear biology. Provide information on human-bear encounters (how to behave) to the inhabitants and visitors of the bear areas.
	upon an accidental close encounter bear is retreating immediately	no action towards the bear (surveillance)	
	upon an accidental close encounter bear is rising on his hind legs	no action towards the bear (surveillance)	
	bear is causing damages in uninhabited areas	damage prevention and basic monitoring to assess the effectiveness of damage prevention	Provide targeted information on why damages happen and how to prevent them (including where to get help).
	bear is repeatedly causing damages in uninhabited areas in spite of prevention measures	intensive monitoring, re-evaluate and adjust damage prevention measures, (deterrence).	Provide targeted information on why damages occur and how to improve damage prevention.
	the bear is aware of your presence but is not running away and ignoring your presence in the natural bear habitat	intensive monitoring (deterrence)	Provide targeted information on human-bear encounters to the inhabitants and visitors

Degree of problem and urgency of action	Individual bear behaviour	Recommended management actions	Recommended public communication actions
	bear is repeatedly coming close to permanently inhabited houses	intensive monitoring, remove attractants and dense vegetation – cover for the bears, if appropriate (damage prevention), aversive conditioning	Provide targeted information to increase understanding of habituation and food conditioning processes and its consequences; information on avoidance of human-bear conflicts
	female with cubs makes a false attack	monitoring	Provide targeted information on avoidance of human-bear conflicts to the inhabitants and visitors and explain causes and possible consequences of the bear behaviour both for the bear and for people. Provide information on human-bear encounters (how to behave when you meet a bear).
	bear makes a false attack when surprised or provoked	investigation, monitoring	
	bear is defending its food by threatening and making false attack	investigation, monitoring	
	bear is searching for food or is causing damages close to inhabited houses	monitoring, damage prevention (remove attractants), aversive conditioning, removal of the dense vegetation (cover for the bear)	Provide targeted information on avoidance of human-bear conflicts (especially damage prevention) to the inhabitants and visitors and explain causes and possible consequences of the bear behaviour both for the bear and for people. Provide channels for two-way communication with the public (bear management hotline, online Q&A section,...).
	bear is entering uninhabited buildings such as barns, stables and sheds close to inhabited houses several times	-removal of attractants, intensive monitoring, aversive conditioning, removal of dense vegetation (cover for the bear) - In populations classified as endangered (IUCN) or better or depending on the social context removal may be considered as the first option.	Provide targeted information on avoidance of human-bear conflicts to the inhabitants and visitors and explain causes and possible consequences of the bear behaviour both for the bear and for people.
	bear attacks (physical contact) a human after being provoked (e.g. by dogs, disturbance of the den)	- in populations classified as endangered (IUCN) or better or depending on the social context removal may be considered as the first option. -intensive monitoring	

Degree of problem and urgency of action	Individual bear behaviour	Recommended management actions	Recommended public communication actions
	bear is repeatedly intruding compact residential areas	<ul style="list-style-type: none"> - removal of attractants, - In populations classified as endangered (IUCN) or better or depending on the social context removal may be considered as the first option. - intensive monitoring and aversive conditioning is preferred in critically endangered (IUCN) populations, 	Provide targeted information and instructions on avoidance of human-bear conflicts to the inhabitants and visitors and explain causes and possible consequences of the bear behaviour both for the bear and for people. Provide channels for two-way communication with the public (bear management hotline, online Q&A section,...).
	bear is defending its food by attacking	intensive monitoring, (deterrence), possibly removal of the bear	Provide targeted information and instructions on avoidance of human-bear conflicts and rationalize management decision by explaining the causes and consequences of the bear behaviour both for the bear and for people.
	bear is following humans in close distance	intensive monitoring, deterrence, removal of the bear if deterrence is not successful	Provide targeted information and instructions on avoidance of human-bear conflicts and rationalize management decision by explaining the causes and consequences of the bear behaviour both for the bear and for people. Provide channels for two-way communication with the public (bear management hotline, online Q&A section,...).
	injured bear attacks a human	removal of the bear	Rationalize management decision by explaining the causes and consequences of the bear behaviour both for the bear and for people. Provide channels for two-way communication with the public (bear management hotline, online Q&A section,...).
	bear cannot be deterred successfully by an expert team from compact residential areas or from repeatedly entering uninhabited buildings next to an inhabited house	removal of the bear	
	bear enters inhabited buildings	removal of the bear	Provide targeted information and instructions on avoidance of human-bear conflicts and rationalize management decision by explaining the causes and

Degree of problem and urgency of action	Individual bear behaviour	Recommended management actions	Recommended public communication actions
			consequences of the bear behaviour both for the bear and for people. Provide channels for two-way communication with the public (bear management hotline, online Q&A section,...).
	bear attacks a human without being intentionally or unintentionally provoked	removal of the bear	Rationalize management decision by explaining the causes and consequences of the bear behaviour both for the bear and for people.

1.6 CONSIDERATIONS FOR SPECIFIC BEAR CATEGORIES

1.6.1 INJURED/HANDICAPPED BEARS

An injured bear will more likely demonstrate a problematic behaviour. In a case when an injured or otherwise handicapped bear occurs, an ad hoc assessment should be carried out by a bear manager (intervention group) and a veterinarian. Taking into account the conservation status of the population and likelihood of the recovery following decisions can be made:

1. Bear will recover by itself, no other actions but intensive monitoring recommended.
2. Provide the bear necessary treatment if feasible, return it to nature and closely monitor its recovery.
3. If complete recovery is unlikely or treatment is not feasible and the population is considered vital, remove the bear from the population.

1.6.2 ORPHANED CUBS

Orphaned bear cubs are not self-sufficient for survival without their mothers until they are at least six months old. Bear cubs which have been raised by humans have a high chance of developing problematic behaviour due to their habituation to humans. Because of that the practice of rehabilitation of human-raised bears is generally not recommended.

1.6.3 FEMALES WITH CUBS AND SUBADULT BEARS

Females with cubs and subadult bears are more likely to become exposed to situations which lead to habituation and food conditioning. For these two categories it is especially important to implement habituation and food conditioning prevention measures (i.e. instructing the public not to offer food to the female with cubs) and aversive conditioning as soon as possible.

CONCLUSIONS

Human-bear conflicts are complex and diverse. Consequently there is no single one-for-all solution to effectively prevent all of these problems. Because often few problem bears cause large part of all bear incidents, special attention needs to be given to preventing development of repetitive conflict behaviour. According to available knowledge, preventing access to anthropogenic food in combination with public education is in many cases the most effective approach. Experiences from several regions suggest that this approach gives best results when local inhabitants are actively involved. Successful preventive management is also considerably more acceptable to public than reactive responses once the conflicts have already occurred. Once problem behaviour is developed in a bear, changing it can be considerable challenge. Well-established monitoring that quickly detects such behaviours is crucial for successful application of aversive conditioning techniques that revise the process of habituation to human presence and/or conditioning to anthropogenic food. Once this process has proceeded to higher stages, considerably more effort will be needed to prevent further conflict behaviour and in some cases bear removal may be the only option.

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The WISO Platform thanks the RowAlps Project for the work done, as well as to all the colleagues and the institutions taking part of its developments. The Platform adopts the RowAlps reports “Lynx and Wolf in the Alps: Recommendations for an internationally coordinated management” as part of the WISO Platform report to be accompanied by an introduction as follows and welcomes them as useful contribution to the fulfilment of the WISO Platform mandate.

Both reports should be considered as living documents that should be further developed as new data, approaches or methodologies come to light. The WISO Platform notes that the reports are based on the population level based management suggested by the Large Carnivore Initiative for Europe (LCIE).

The definition of Favorable Conservation Statuses for the entire Alpine lynx and wolf populations and the quantitative values for each Alpine country were elaborated on the basis of one of the suitable approaches available and should be further developed taking into account also the outcomes of the *ad hoc* Working group of the European Commission as well as relevant studies and publications, where appropriate.

The WISO Platform will present the WISO Report to the relevant bodies of the Alpine Convention in 2016, and will look for the opportunity to present it to the *ad hoc* Working group of the European Commission.

Lynx in the Alps: Recommendations for an internationally coordinated management



KORA Bericht Nr. 71

Lynx in the Alps: Recommendations for an internationally coordinated management

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Lynx B306 pictured above Ebligen, near Lake
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Lynx in the Alps: Recommendations for an internationally coordinated management

Report of the RowAlps Project (Recovery of Wildlife in the Alps) in the framework of the WISO (Wildlife and Society) Platform of the Alpine Convention

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Abstract

The RowAlps (Recovery of Wildlife in the Alps) Project was founded in order to support the Platform “Large Carnivores, Wild Ungulates and Society” (WISO – Wildlife and Society) in fulfilling its Alpine Convention Mandates for the periods of 2013-2014 and 2015-2016: Develop practical goals and management options for the recovery and conservation of wolf, lynx and bear populations in the Alps and present these to the relevant bodies of the Alpine Convention.

Therefore, the overall goal of the RowAlps Project is to develop practical goals and management options for the recovery and conservation of wolf and lynx populations in the Alps. To reach this goal three objectives were defined. In brief these objectives are: 1) To review and assess the present situation of wolf, lynx and prey populations in the Alps, the expected development of the populations and discuss challenges in wildlife management as a consequence of the return of the carnivores; 2) To describe mechanisms to achieve tolerance for lynx and wolf for different interest groups and to identify factors defining the tolerance and the potential measures to influence these factors and 3) To assess the output from objectives 1 and 2 and develop management scenarios for the recovery and conservation of favourable wolf and lynx reference populations in the Alps and discuss them with interest groups.

For objectives 1 and 2, each a working group was established with experts and interest groups. For objective 3 a working group with delegated representatives of the country delegations of the WISO Platform was established.

The current report is the product of the working group assigned with fulfilling the 3rd objective. In seven chapters the following contents are presented: 1) Introduction; 2) Framework for large carnivore management; 3) Current situation of the lynx population in the Alps; 4) Discussion, interpretation and assessment of a future Alpine lynx population and main threats; 5) Practical goal; 6) Management options and implications and 7) Suggestions for priorities in time and space.

The RowAlps Project identified its *overall practical* goal as achieving a favourable conservation status (FCS, according to Linell et al. (2008)) of lynx in the Alps. To reach FCS for the Alpine lynx population, *at least 1000 mature individuals (lynx > 2 years of age)/1300 independent individuals (lynx > 1 year of age) need to be widely and evenly distributed across the Alps*. In other words, a minimal density of 1,3 lynx > 1 year of age per 100 km² favourable habitat is needed across the entire Alps. The *main threats* to the present and future Alpine lynx population were identified as illegal killing, inbreeding, habitat fragmentation, low acceptance and poor management structures. To address these threats, a set of *seven general management options* for the entire Alpine lynx population were identified: 1) Merge eastern and western subpopulations, 2) Active genetic management, 3) Secure and construct new connection corridors, 4) Prevent and persecute illegal action through law enforcement, 5) Foster dialogue among authorities, with wildlife managers, hunters and foresters by establishing information and consultation mechanisms regarding the lynx, 6) Integrate local people in lynx monitoring and 7) Secure sustainable damage prevention and compensation systems for livestock damages. Although there may be some regional and national variation in the priority of implementing these management options, *the level and timing of priority* for each of the seven management options were identified.

The current conclusions were elaborated on the basis of the suitable approaches and data available at the time of writing this report.

1. Introduction

1.1 Assignment and context of the present recommendations for an internationally coordinated management

The Platform “Large carnivores, wild ungulates and society”(WISO – wildlife and society) was set up by the X Alpine Conference in 2009 (Evian). Liechtenstein was assigned with the first presidency. Switzerland was allocated the second presidency by the XI Alpine Conference and Italy the third presidency by the XII Alpine Conference.

For the period of 2013-2014 the Platform dealt with the following mandate:

- Development of practical goals and management options for the recovery and conservation of wolf, lynx and (according to availability of funds) bear populations in the Alps and presentation to the relevant bodies of the Alpine Convention;
- Working towards an Alpine-wide genetic monitoring programme for large carnivores;
- Development of a map with the distribution and abundance of the Alpine ibex population in cooperation with the Alpine Ibex Group.

The “spirit of WISO” is based on the Alpine Convention and is expressed by the first president of the Platform, Felix Näscher with the following words:

“To ensure the continued existence of viable populations of large carnivores, regional planning must start taking their needs into account, e.g., by guaranteeing migration corridors, by defining tranquillity wildlife areas, by conserving functioning ecosystems, by applying adequate management strategies and measures as demanded by the protocols on “Spatial planning and sustainable development” and “Conservation of nature and the countryside”.

A functioning ecosystem comprises both large predators and their prey species. Therefore, any concept for the conservation and management of wildlife species – be it large carnivores or wild ungulates – has to be based on a holistic and integral approach. Thus, speaking about large carnivores, you have to take into account the status of possible prey populations and of their habitats over the entire area occupied by these species; and, speaking about wild ungulates, you have to reflect the influence of predation by large predators over the entire area occupied by these species: Finally and above all, you have to go beyond a strictly ecological approach.

Any successful determination of development targets, strategies and measures with respect to these wildlife species will have to take it for granted, that economic and social aspects are duly taken into account on an equal level: Sustainable conservation and exploitation of wildlife can only be ensured when respecting and assessing all of these ecological, social and economical parameters, which are determining the system at stake.

Sustainable wildlife management can’t never be a question of purely scientific knowledge – far away from it: Sustainable wildlife management has to be an expression of a will, how to deal with our wildlife species - by taking into account, by balancing and by harmonising ecological, economical and socio-cultural interests: A decision of all stakeholders involved is required - or let`s just say, a decision by society” (Näscher 2009).

To fulfil the overall goal the WISO Platform members understood, that additional expertise is necessary to analyse adequately the data and information of the different countries and to develop

appropriate solutions for the entire Alpine arc. This additional work, which goes beyond the Platform's capacity, is covered by the especially designed RowAlps project¹ for lynx and wolf. The project is financed by the MAVA foundation, Switzerland (Federal Office for the Environment) and Germany (Bundesministerium für Umwelt, Naturschutz, und Reaktorsicherheit). Switzerland coordinates and leads this project. The RowAlps project started in 2012 and will end in 2016.

The Alpine Convention Mandate of WISO for the period of 2015-2016 was adopted at the XIII Alpine Conference in Torino, on November 21st 2014. It focuses on the following tasks:

- *“To finalise drafting of practical goals and management options for the recovery and conservation of wolf and lynx populations in the Alps; to continue the development of practical goals and comprehensive advice for the application of management options in relation to recovery and conservation of bears in the Alpine region; to present all management options to the relevant bodies of the Alpine Convention in 2016.*
- *To develop procedures among the contracting parties concerned, which ensure a transparent flow of information and support decision-making processes as well as the coordination of responding actions for wolves and bears; common interpretations of behaviour of problem bears; and more effective and coordinated conservation actions for the lynxes involving the key stakeholders.*
- *To continue the development of coordinated programmes of genetic monitoring of wolves and bears on an Alpine scale, and to ensure a profound understanding of the genetic risks for the conservation of the lynxes to guide conservation policies in the Alps.*
- *These goals are to be pursued taking into account the results of the RowAlps project and other relevant projects, including EU-funded projects, and exploring synergies with the EU Platform on coexistence between people and large carnivores and other relevant initiatives”* (Alpine Convention 2014).

1.2 Main goals and general orientation of the guidelines „Large carnivores, wild ungulates and society“ of the Alpine Convention

The work of the WISO Platform (and RowAlps) is based on and guided by the WISO guidelines that were adopted by the XI Alpine Conference in 2011 (Slovenia).

The main goal and general orientation of the guidelines is to achieve and conserve the favourable conservation status of wolf, lynx and bear in the entire Alps. Subgoals and options define the orientation of the WISO Platform to achieve the main goal.

¹ Recovery and conservation of wolf and lynx in the Alps: Options for transboundary conservation and management.

“MAIN GOAL – GENERAL ORIENTATION

Large carnivores and wild ungulates are preserved in balance with their habitat, other wildlife and human interest. Conflicts with human interests are addressed and negative impacts are counterbalanced. [...]

Subgoals

1 - Dialogue: We inform, sensitize, and promote dialogue concerning the relations between wildlife, habitat, and society;

2 - Wildlife populations: We respect the intrinsic value of our wildlife as central components of our environment and steer the development of native wildlife populations in harmonization with their habitat and human interests, with the goal of securing viable wildlife populations;

3 - Wildlife habitat: We support close to nature land-use forms when using mountain pastures, agricultural areas and forests and aim for the conservation and improvement of wildlife habitats in terms of surface and quality;

4 - Integrative sustainable use: We use our wildlife sustainably, in recognition of and in harmonization with the various human interests in protection and use, and we further develop the various land use forms in a balanced manner;

5 - Cooperation: We cooperate transboundary in a cross-sectoral way and harmonize measures, as far as it is needed to reach common objectives, such as the amelioration of living conditions for wildlife species or the prevention of conflicts as regards different user interests as well as compensation of damages” (WISO 2011).

The WISO (wildlife and society) Platform, takes the role of a “Think Tank”. WISO supports the member states and decision makers on a national and international level to achieve and conserve the favourable conservation status of the lynx, wolf and bear in the entire Alps. A special focus is given to cross border issues, international cooperation and necessary harmonization of processes relevant for a population level management.

1.3 Goals of the RowAlps project and current specification of the tasks

The overall goal of the RowAlps project is to develop practical goals and management options for the recovery and conservation of wolf and lynx populations in the Alps. These suggestions will support WISO to fulfill its current mandate.

To reach this goal, three objectives were defined and for each of them a working group was established.

Objective 1: To review and assess, based on available scientific publications and reports, statistical materials and up-to-date experience, the present situation of wolf, lynx and prey populations in the Alps, the expected development of the populations and discuss challenges in wildlife management as a consequence of the return of the carnivores.

Objective 2: To describe mechanisms to achieve tolerance for lynx and wolf for different interest groups and to identify factors defining the tolerance and the potential measures to influence these factors.

Objective 3: To assess the output from objectives 1 and 2 and develop, considering these biological-ecological and socio-economic findings, management scenarios for the recovery and conservation of favourable wolf and lynx reference populations in the Alps, discuss them with interest groups (in the frame of the WISO Platform), and report to the relevant bodies of the Alpine Convention.

These recommendations are based on the reports of the RowAlps objectives 1 and 2, further on the fact finding of the WISO Platform, on inputs of the members of working group 3 of the RowAlps project and finally on different documents, that have been drafted by WISO since its establishment in 2009.

The overall goal and objectives were fine-tuned during the discussions of three RowAlps workshops as well as the WISO Platform meetings during 2014. The working groups of objective 1 and 2 produced two separate reports².

1.4 Management definition

The members of the RowAlps project define management as follows: *“Management is any goal-oriented and deliberate intervention within the existing legal framework, carried out by an authorised or mandated actor. The WISO Platform defines management as a value-neutral term that can embrace a wide variety of involvements with large carnivores, their wild or domestic prey species, and habitats or with people. Regarding the carnivores, it could include activities such as translocation and reintroduction, culling and capturing, or also intentional (temporary) non-intervention, but implies always, as it is goal-oriented, a kind of monitoring. Regarding society, it could include activities such as communication, participation, compensation and damage prevention and social monitoring.”*³

Management in the present recommendations is understood as: All legal activities in the biological and socio-political sphere with the goal of achieving a favourable conservation status of the lynx and wolf:

- on a biological level “management” includes different actions such as conservation, maintaining habitats, lethal removal of single specimens which e. g. are posing a threat to the human population (under the strict conditions laid down in § 16 of the Habitats Directive and the Bern convention) and other actions,
- on a socio-political level “management” means also dialogue, communication and cooperation.

1.5 Scope of the recommendations

The geographical focus for the present recommendations is the Alpine arc. The overall management of lynx and wolf across the Alpine arc focuses on international cooperation, whereas the concrete management options and strategies are understood as a transboundary framework.

² RowAlps report objective 1: The recovery of wolf *Canis lupus* and lynx *Lynx lynx* in the Alps: Biological and ecological parameters and wildlife management challenges. April 2015
Row Alps report objective 2. December 2014

³ Workshop of the working group 3 of the RowAlps project, Vienna, 6th – 7th December 2012

1.6 Addressees

These recommendations address in the first place the official authorities of all member states of the Alpine Convention responsible for strategic planning and in charge of concrete actions concerning the conservation of large carnivores and wild ungulates. The recommendations provide a basis for decision-making regarding:

- strategic planning activities;
- concrete actions to balance large carnivores and wild ungulates with their habitat, other wildlife and human interest; as well as to address conflicts with human interests and counterbalance negative impacts.

Furthermore, they may serve as orientation for all non-governmental actors involved in wildlife management and finally as common vision for the realization of the overall goal to achieve a favourable conservation status of the lynx throughout the Alps.

More detailed reports, good practices, links on initiatives, references are available on the Alpine Convention web site⁴ and MALME website⁵.

2 Framework for large carnivore management

2.1 Legal framework of international and national treaties on large carnivores and population level management

Large carnivores have populations distributed across several countries and can have large individual home ranges, often >100 km². Therefore, legal instruments to protect these species need to be coordinated at an international level, and several international treaties have been established to address transboundary conservation.

The EU Habitats Directive

The EU Habitats Directive ("Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora") is a European Union directive adopted in 1992⁶. All the large carnivore species as well as their habitat are strictly protected by the Habitats Directive (annex II, which requires Natura 2000 sites, and annex IV). Wolf and brown bear, but not lynx, are additionally designated as priority species.

"Formally, the Habitats Directive does not explicitly specify that Favourable Conservation Status (FCS) should be achieved at the population level. Its reporting routines require that FCS be evaluated within each country (or within each biogeographical region present within each country), indicating that its intention is to operate on a national or sub-national scale. This scale of consideration may be suitable for a wide range of smaller species, but large carnivores present a wide range of very special challenges. As large bodied top-predators they naturally move over very large areas and occur at relatively low densities. This implies that many (maybe most) countries will never be able to host enough individuals to have a population that can reach FCS. In order for the intention of the Directive

⁴ <http://www.alpconv.org/en/organization/groups/WGCarnivores/default.html>

⁵ http://www.kora.ch/malme/20_malme/home/index_en.html

⁶ http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm

to be achieved for a species group like large carnivores, it must consider spatial scales that span borders. This is actually specified in the Directive's preamble as one of the prime objectives of the Directive. These population level management plans can simply be viewed as an instrument to achieve this goal. The Commission also says in its technical specifications for the tender of this project that "coordinating the management across national boundaries might be the solution to maintain viable populations over the long-term, an approach that is also important to put large carnivore conservation into the broader context of biodiversity conservation". A certain legal clarification is, however, required from the European Commission concerning the proposed practice of attaching favourable conservation status assessment to the population level, which in some cases may free member states from the obligation to achieve it on their own" (Linnell et al. 2008).

Formal requirements towards EU member states are more than "just avoiding extinctions". The requirement is to reach the Favourable Conservation Status (FCS), based on two reference values: Favourable Reference Range (FRR) and Favourable Reference Population (FRP). The "Member States shall undertake surveillance of the conservation status of the natural habitats and species referred to in Article 2 with particular regard to priority natural habitat types and priority species." (Article 11, EU Habitats Directive).

On behalf of the European Commission, the Large Carnivore Initiative for Europe elaborated the "Guidelines for Population Level Management Plans for Large carnivores" in 2008. The goals of these guidelines are:

1. To shift the focus from the species and the management unit to the (meta-) population.
2. To interpret FCS-term „Favourable Conservation Status“ for correct and concrete use.
3. To recommend „best management practices“ for large carnivores.

The Natura 2000 network was established under the Habitats Directive and comprises of a series of protected areas within the European Union (Emerald-Network for Switzerland and Liechtenstein).

The Bern Convention

All Alpine States and the European Union have signed the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). It lists wolf and brown bear as strictly protected (Appendix 2), while lynx is listed as protected (Appendix 3) together with the ungulate species. For species in Appendix 3 hunting is allowed as long as the population is not threatened.⁷

"The Bern Convention places considerable emphasis on the need to foster transboundary approaches in the preamble and in articles 1, 10 and 11. Recommendation 115 (2005) also calls for countries to work towards transboundary action plans for large carnivores, and the topic was given considerable attention in a workshop held in Slovenia in 2005 (Bath 2005)" (Linnell et al. 2008).

The Bonn Convention

Furthermore, the Alpine countries are signatories to the Convention on the Conservation of Migratory Species of Wild Animals (CMS, Bonn Convention)⁸, which is specifically tailored to migratory species that cross international borders. The Bonn Convention even allows for states sharing migratory populations to sign legally binding treaties to govern the management of these species. Although the movements of large carnivores across borders do not follow the strict

⁷ WISO Platform. Results of fact finding in the frame of the Platform, "Large Carnivores and Wild Ungulates". 2010

⁸ <http://www.cms.int/>

definition of seasonal migration, it may be worthwhile exploring the potential for use of this convention, which has already been applied to several similar issues.

Whereas given that threatened habitats and species form part of the Community's natural heritage and the threats to them are often of a transboundary nature, it is necessary to take measures at Community level in order to conserve them:

“The combined weight of the Habitats Directive and these two conservation conventions should be enough to motivate EU countries to develop population level management plans, especially if in so doing they will be permitted to adopt more flexible management practices than those allowed by a strictly national perspective. Furthermore, the Bern and Bonn Conventions should be useful frameworks to induce non-EU countries to take part in these plans. Although many Bern Convention signatories have taken reservations for wolves and bears concerning their placement on appendix II – these species are still covered under the Conventions general goals as expressed in articles 1 and 2” (Linnell et al. 2008).

The Alpine Convention

The Alpine Convention is an international treaty (convention) for the protection of the Alps. It was signed beginning from 1991 by the eight countries of the Alpine Arc: Austria, France, Germany, Italy, Liechtenstein, Monaco, Slovenia and Switzerland and the European Community. Every two years is conducted an Alpine Conference in the country holding the presidency.

The Convention works with integrated policies and approaches for the sustainable development of the Alpine Space. Twelve key themes and out of them eight protocols, support the parties to navigate the implementation of highly complex sustainable developments in the Alps.

The Permanent Committee and the competent administrations are the main institutions primarily responsible for the Convention implementation. Working groups, platforms, committees etc. support and supervise the implementation of the Convention. One Platform of the Convention is the WISO (Wildlife and Society) which deals with large carnivores and wild ungulates.

Main themes and the protocols with relevance for large carnivores and wild ungulates in the Alpine Convention are

1. Spatial planning
2. Nature protection and landscape conservation
3. Mountain agriculture
4. Mountain forestry

Protocol „Spatial planning and sustainable development“

Article 3 of the protocol aims at considering of the criteria for environmental protection in the policies for spatial planning and sustainable development:

The spatial planning and sustainable development policies aim to achieve swift harmonisation of the economic interests with the needs for protecting the environment, with particular attention inter alia to:

- a) safeguarding and restoring the ecological balance and the biodiversity of the Alpine region, [...]
- d) the protection of ecosystems, the species and rare landscape elements

And Article 9 of the protocol asks the countries that spatial and sustainable development plans and/or programmes include, at the most appropriate territorial level and taking account of the specific territorial conditions,: [...]

4. Protection of nature and the landscape

a) delimiting of the areas for protecting nature and the landscape, and also for safeguarding the water courses and other vital natural resources,

b) delimiting of tranquil areas and areas in which construction of buildings and infrastructures is restrained or prohibited, as are other damaging activities.

Protocol „Conservation of nature and the countryside“

The objective of this Protocol is to lay down International laws, implementing the Alpine Convention and also taking the interests of the local population into account, in order to protect, care for and, to the extent necessary, restore nature and the countryside, in such a way as to ensure the lasting and widespread functional efficiency of the ecosystems, the conservation of countryside elements and wild animal and plant species together with their habitat, the regenerative ability and lasting productivity of natural resources, and also the diversity, specificity and beauty of the natural and rural landscape; and also, in order to encourage cooperation between the contracting Parties for these purposes.

The Contracting Parties undertake to cooperate particularly for: map surveying, drawing the boundaries and then managing and controlling protected areas and other natural and rural elements of the landscape worthy of protection, interconnecting a network of biotopes, defining landscape models, programmes and/or plans, preventing and rebalancing damage to nature and the landscape, systematically monitoring nature and the countryside, scientific research, and any other measure for protecting wild animal and plant species, their diversity and their habitat, and for defining the relevant comparable criteria to the extent that this is necessary and functional (Art. 3.1).

The Contracting Parties undertake to pursue the measures appropriate for preserving the indigenous animal and plant species with their specific diversity and in sufficient populations, particularly ensuring that they have sufficiently large habitats (Art. 14.1).

Finally the Contracting Parties shall undertake to promote the reintroduction and distribution of wild, indigenous animal and plant species and also subspecies, breeds and ecotypes, on condition that there are the necessary prerequisites and, by doing this, there is a contribution to the preservation and strengthening of those species and that no effects unsustainable to nature and the landscape, or to human activities, are caused (Art. 16.1). Scientific knowledge is to be applied for reintroducing and distributing these species. The Contracting Parties shall agree on common directives in this respect. Following the reintroduction, it will be necessary to control and, if required, regulate the development of these animal and plant species (Art. 16.2).

Protocol „Mountain farming“

In Article 13 of the protocol the Contracting Parties agree that the complementary nature and partial interdependence of farming and forestry in mountain areas necessitate an integrated approach. Consequently, they shall encourage:

(a) forestry compatible with nature both as an additional source of revenue for farms and as a sideline activity for farm workers;

(b) consideration of the protective, productive and recreational as well as the environmental and biogenetic functions of forests, in relation to farmland, taking account of the specific local conditions and in harmony with the countryside;

(c) regulation of grassland farming and of the game population, to avoid any intolerable damage to forests and crops.

Protocol „Mountain forests“

The Contracting Parties undertake to also consider the objectives of this Protocol in their other policies. This primarily applies to the following areas: [...]

b) Populations of game. The game population is to be contained within limits permitting the natural reforestation of the mountains by indigenous trees, without having to take recourse to special protective measures. In the border areas, the Contracting Parties undertake to harmonise their measures for regulating the game animals. To restore a system of natural selection on the hoofed species, and also in the interest of protecting nature, the Contracting Parties shall encourage the reintroduction of predators, to an extent appropriate for the general needs of the region (Art. 2).

CITES

The Convention on International Trade in Endangered Species of Wild Fauna and Flora, is an international agreement between governments to ensure that international trade in specimens of wild animals and plants does not threaten their survival. It came into force in 1975. Lynx is listed in Appendix 2 (www.cites.org). In the EU countries CITES is implemented by EC regulation 38/97.

The national laws on hunting and on large carnivores

In the Alpine countries wildlife is managed through legal and practical means such as protective laws and selective hunting.

Lynx is granted protection in all Alpine countries, in Germany it is strictly protected. However, there are exceptions mainly concerning livestock raiding individuals which are removed in France and Switzerland. In most of the countries, national authorities are in charge of lynx conservation and management. However, in Germany, Austria and partly also in Switzerland, power is delegated to the regional authorities. Complete legal protection of lynx was adopted in Slovenia in 2004 (Kos & Potočnik 2013). To prevent local extinction, according to Kos et al. (2012) an active approach addressing demographic factors as well as improving the depleted gene pool is needed for a revitalisation of the population.

In France, wildlife and environmental monitoring are carried out by the Office National de la Chasse et de la Faune Sauvage ONCFS. The role of hunting in Italy is primarily to control wild boar, red deer and roe deer populations (Apollonio et al. 2010). Switzerland has licence hunting across the Alpine range, with 41 federal wildlife reserves where hunting is banned (Imesch-Bebié et al. 2010). Ungulate management and hunting practices in Germany are carried out with the objective of reducing and preventing damage to crops and forests. There is a federal hunting law, but the 16 "Bundesländer" all have additional regulations (Wotschikowsky 2010). Austria uses the "Reviersystem" similar to the system in Germany; the Austrian "Bundesländer" are responsible for legislation and management of game (Reimoser & Reimoser 2010). The current Slovenian Law on Wildlife and Hunting controls the wildlife management system in Slovenia (Adamic & Jerina 2010).

Table 1: Legal status of lynx, restrictions to the status and authority in charge for lynx conservation and management in the Alpine countries.

Country	Legal status	Management interventions	Authority in charge
France	Strictly protected.	Selective removal of stock raiding individuals.	Ministère de l'écologie, du développement durable et de l'énergie
Italy	Strictly protected.		Ministry of Environment; enforcement of general policies by the local administrations
Switzerland	Strictly protected.	Selective removal of stock raiding individuals. Criteria for population regulation under discussion.	Federal Office for the Environment FOEN; the cantons for the implementation of the lynx concept (Chapter 6.1.2).
Liechtenstein	Strictly protected.		Amt für Umwelt (former Amt für Natur, Wald und Landschaft).
Germany	Strictly protected, but also subject to the hunting law with year-round closed season.		Nature conservation authorities of the federal states, but the respective hunting authorities also have a responsibility.
Austria	Mainly subject to the district's hunting laws, but year-round closed season.	Special permits to shoot a lynx to be issued by the district authorities on request, so far never used.	Hunting and nature conservation authorities of the provinces.
Slovenia	Strictly protected since 2004 (before quota hunting from October to February)		Ministry of Environment and Spatial Planning

2.2 Administrative framework concerning current management of large carnivores at national and local level of Alpine countries

All Alpine countries have a decree that defines, which species are protected and which ones are hunted. While e.g. the authority in charge is the state in France, in Austria the federal provinces (Länder) are responsible for large carnivores and wild ungulates.

In Austria, the three large carnivores are managed under the hunting law with year-round closed hunting season.

In France, wolf and bear management are organized at the national level through national action plans. The actions planned at national level are put in practice by departmental authorities and coordinated at the regional level. Lynx conservation is managed at regional and departmental levels, except for derogation to its protection status which implies a decision at national level.

In Germany all large carnivore species are strictly protected by the Federal Nature Conservation Act and the lynx in addition in the national hunting law with year-round closed hunting season. The administrative structure of huntable species in Bavaria is divided in three levels: local, the district and state level (Ministry of Food, Agriculture and Forestry).

In Italy large carnivores are protected on ministerial level and the ungulates are contained in the regional hunting law.

In Slovenia, protected species (bear, wolf, lynx) are regulated by nature protection legislation, game (chamois, ibex, roe deer, red deer, wild boar, mouflon) are regulated by hunting legislation.⁹

In Switzerland and Italy the general conditions are defined in the national laws, but some species are managed on cantonal or regional level, respectively. In Switzerland all three large carnivores are protected by federal law. The federal law also gives the general guidelines about wild ungulate management, but delegates the management itself to the cantons.

France, Switzerland, Germany and Austria have established large carnivore management boards with representatives of GOs, NGOs and scientists as discussion forums on regional and/or national level. The aim is an objective discussion about emerging problems and possible solutions to serve conflict management.¹⁰

Liechtenstein will in future be integrated in the management plans of Switzerland.

Table 2: Countries with operative management plans for large carnivores for the whole Alpine part of the population ✓ or regionally [✓].

Species	France	Italy	Switzerland	Liechtenstein	Germany	Austria	Slovenia
Wolf	✓	✓	✓		✓		✓
Lynx			✓		✓		
Brown bear	✓	[✓]	✓		✓	[✓]	✓

In Germany there is no nation-wide policy concerning lynx management. So far, only Bavaria has a regional lynx management plan (StMUGV 2008). In that respect, projects implementing transboundary cooperation and monitoring are done regularly with Czech Republic and Austria working on the Bohemian-Bavarian-Austrian population (e.g. Wölfl S. 2015).

Switzerland is the only Alpine country that has elaborated and implemented a lynx management plan. The first “Swiss Lynx Concept” was endorsed in August 2000 and was revised in 2004 (BUWAL 2004a). It defines the general conservation and management goals, the co-operation between the Federal Office for the Environment FOEN and the cantons, and criteria for interventions.

A national lynx management plan for Slovenia is in development. The document is expected to formulate and formalise the management goals and facilitate the implementation of a planned population augmentation project (Kos & Potočnik 2013). It is currently in the final stage and expected to be adopted by the Slovenian Government in 2015 (M. Jonožovič, pers. comm.).

In 2003, a Pan-Alpine Conservation Strategy PACS for the lynx was published (Molinari-Jobin et al. 2003) under the hospice of the Bern Convention. The strategy was elaborated by the SCALP expert group (Chapter 4.1) and proposed standards aimed at boosting transboundary activities and co-operation from local to international levels. The goal of the strategy was “to establish and maintain, in co-existence with people, a vital lynx population covering the whole of the Alpine arc” (Molinari-Jobin et al. 2003). This goal was then specified in four objectives:

⁹ WISO Platform. Results of fact finding in the frame of the Platform, “Large Carnivores and Wild Ungulates”. 2010

¹⁰ WISO Platform. Results of fact finding in the frame of the Platform, “Large Carnivores and Wild Ungulates”. 2010

1. The lynx populations in Slovenia and Switzerland maintain their vitality and must be helped to expand;
2. The populations in Slovenia and Switzerland are joined through colonisation of the area in between (Alps of Austria, Germany, Italy and Liechtenstein);
3. This unified population in the central Alps is allowed to expand to the north-east (Austria) and the south-west (France, Italy);
4. Gene flow is assured between the Alpine sub-populations and the population of Slovenia and Croatia, the population of the Jura Mountains and the population of the Bohemian/Bavarian forest.

To operationalise these objectives, actions on the pan-Alpine level as well as for each country were proposed (Molinari-Jobin et al. 2003). However, this Pan-Alpine Conservation Strategy was never implemented at the national level.

Wolf and lynx are strictly protected by international and national laws, but with regard to practical management, almost all countries having substantial populations of these carnivores are applying some regulations allowing for exceptional removals of problem animals. For the wolf, France is applying the principles of “tir de défense” and “tir de prélèvement”, and Switzerland has set limits for how many livestock a wolf is allowed to kill before it can be lethally removed.

2.3 Human developments in the Alps

Since 1871, the resident human population in the Alps has almost doubled, from 7.8 million to 15.2 million people (Bätzing 2015). However, the population development has varied hugely within the Alps and the population distribution became much more uneven: the majority of people live below 500 m. Areas along major transport routes have become urbanised and cities at the edges of the Alps have become “commuter towns” for the metropolises surrounding the Alps. Tourist destinations have grown, too. The population has increased especially in the western parts of the eastern Alps. The population in higher elevation areas has decreased, mostly because agriculture has become unprofitable due to limited mechanisation. The population decrease was most prominent in the Italian Alps (except South Tyrol), eastern Austrian Alps, and some regions in the French Alps. Young people and families moved away, and the population in these communities is considerably over-aged. A further population decrease is expected in areas with unfavourable economic conditions.

Tourism in the Alps has been stagnating on a high level since the early 1980s. About 60 million people visit the Alps every year for daytrips and an additional 60 million people stay for 370 million nights in the Alps every year (Siegrist 1998). However, tourism is spread unevenly across the seasons and across the Alps (37% of municipalities in the Alps offer no tourist beds at all; Price et al. 2011).

The influence of tourism on large carnivores and wildlife in general is twofold: Firstly, tourism requires infrastructures (e.g. transport infrastructure, ski slopes, or golf courses), which influences the landscape and the habitat of wildlife. Secondly, touristic activities (e.g. hiking, skiing, paragliding, but also added traffic from visitors) create disturbances for the local wildlife. Nonetheless, the populations of ungulates have increased throughout time. Large carnivores have a high capacity to adapt to human activities. Wildlife and especially large carnivores also represent a chance for tourism as visitors see them as the embodiment of pure nature and untamed wilderness. Wildlife tourism is however weakly developed in the Alps.

2.4 Ecological framework

Habitat loss and fragmentation are the leading human-caused deterministic factors affecting wildlife populations with effects being caused by e.g. altered connectivity or increased edge effects (Mills 2007).

The fragmentation of the landscape in Europe is increasing, which has various negative effects on wildlife (e.g. barrier effect, loss of habitat, increased numbers of traffic collisions). Nevertheless the Alps still feature some of the largest unfragmented low-traffic areas in Central Europe but valley floors can be just as heavily settled and fragmented as the lowlands surrounding the Alps and present considerable barriers for animal movements.

The Alps are one of the best-known mountain ranges as well as being one of the richest in biodiversity, it is, however, also one of the most densely populated. The traditional tool used to conserve biodiversity and the natural environment has always been the creation of protected areas, however it has become increasingly obvious that a majorly important aspect in the conservation process is to connect protected areas to one another to allow the migration of species across the entire Alpine range.

Besides the extent and quality of forests (which have improved over the past 100 years in the Alps), the connectivity between forest patches is decisive for far-roaming terrestrial species.

Forests in the Alps have been strongly overexploited in the 18th/19th century, but have recovered and forested areas have expanded again in the 20th century. About 52% of the Alpine area is forested, and “forest creation and management” contributes the majority to recent changes in land cover (EEA 2010).

The realisation of an ecological continuum and the reduction of fragmentation lead to concrete spatial links (corridors) and measures in favour of the establishment of a pan-alpine ecological network (ECONNECT 2011).

Genetic flow across the whole Alpine range is important. Across the whole Alpine range a coordinated and transnational approach is needed in accordance with the legal framework provided by the Alpine Convention. Together with the “Ecological Continuum initiative” and the “Platform Ecological Network” of the Alpine Convention, Econnect created the Alpine ecological network to join efforts focussing on the Alpine massif as a whole in order to create a functioning ecological network in the Alps to contribute to conserve the extraordinary rich alpine diversity.¹¹

According to the analysis of the ECONNECT Project¹², for lynx the attention should be drawn to motorways as they are the major barriers for the migration of lynx populations. Conservation should aim at the connection of core areas that are separated by motorways. Settlements as they are at the moment, seem to have little negative impact on lynx in the Alps.

¹¹ <http://www.alpine-ecological-network.org/the-alpine-ecological-network>

¹² ECONNECT, Alpine Space Project, 2008-2011, <http://www.econnectproject.eu/cms/?q=homepage/en>

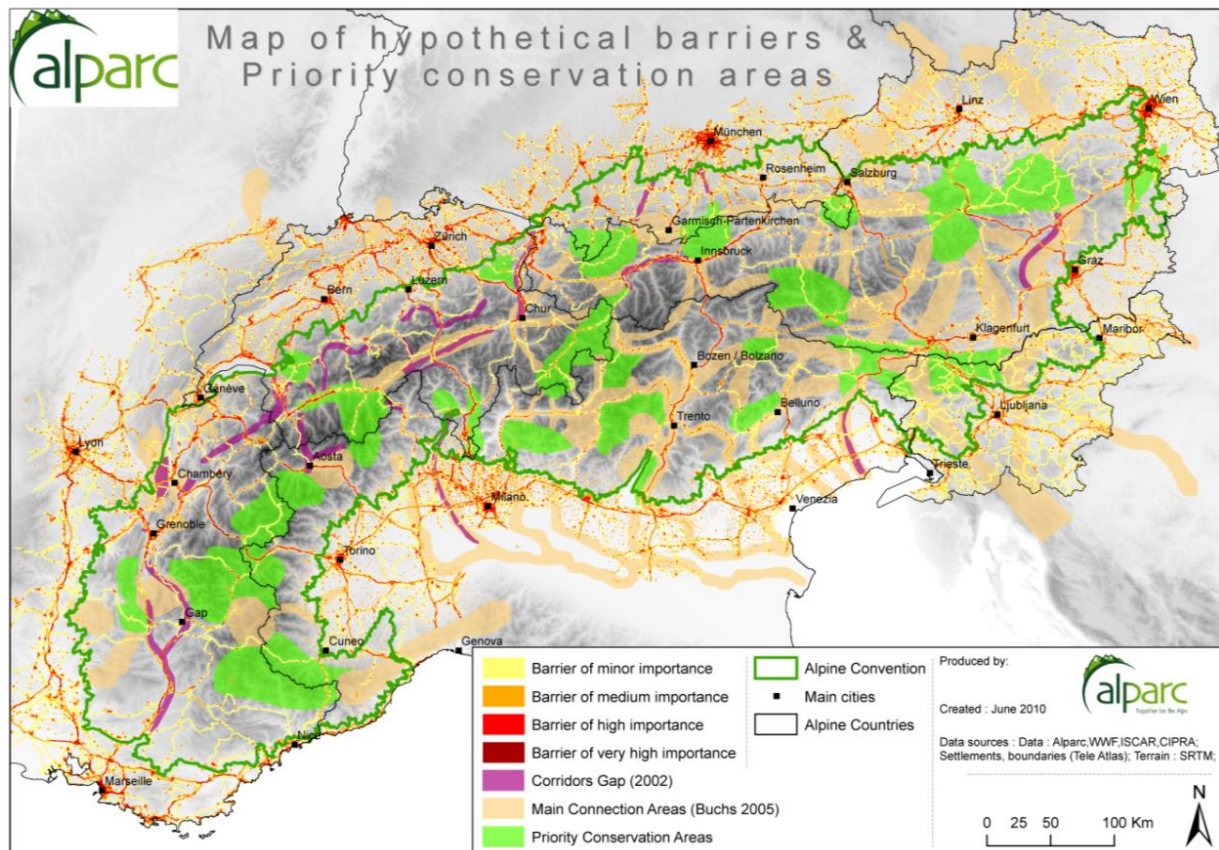


Fig. 1: Map of barriers and priority conservation areas. The map was based on expert opinion expressed during a workshop for the Ecological Continuum Initiative in 2010.

While enough suitable habitat and prey in the form of wild ungulates are available to lynx, one of the major threats lies in the fragmentation of said habitat. Some of the fragmentation stems from the natural Alpine landscape (e.g. high mountain ridges), but much of it originates from anthropogenic structures, especially in the lower regions. As a result, there is a lack of connectivity within the Alps as well as to other populations adjacent to the Alps. Although individual lynx have the ability to cross most types of barriers, its dispersal ecology is such that the population as a whole cannot overcome them. Consequently, there is a lack of population expansion, which contributed to a high amount of inbreeding in the population.

A natural population expansion over the whole of the Alpine Arc is highly improbable, even in the long term (Chapter 4.2). Therefore, the anthropogenic support is required and needs to be organised. A way to aid the expansion of the lynx population are translocations and further small-scale reintroduction projects as the ones carried out in north-eastern Switzerland or in the Kalkalpen National Park in Austria. These were indeed the latest significant population developments in the Alps. Rüdissler (2002) proposed such an approach also for the western Austrian Alps. Reintroduction projects in southern Vorarlberg, eastern Tyrol and western Salzburg would allow establishing further subpopulations and eventually connect the now isolated lynx occurrences in the Alps (Rüdissler 2002).

3. Current situation of the lynx population in the Alps

3.1 Return of the lynx to the Alps and population development

The historic decline and eventual eradication of the large carnivores in the Alps between 1800 and the early 1900 proceeded in parallel and was related to the expanding human population and the over-exploitation of natural habitats and resources, including forests and game. Increasing numbers of sheep, goats, cattle and horses affected the forests negatively due to browsing and out-competed the wild ungulates. The large predators were forced to kill livestock and were therefore persecuted, encouraged by governmental bounties. However, hunting alone did not lead to the eradication of the large carnivores. Only the massive intervention at the level of the landscape (forests) and the substantial reduction of wild ungulates led to the final eradication of lynx and wolf (Zimen 1978, Breitenmoser 1998a).

A radical change in forest management and the growing sensitivity of people for the protection of nature in the first half of the 20th century were the basis for the recovery of the forests (Breitenmoser 1998a). Wild ungulates started to recover and expand from remnant source populations after they were granted a certain legal protection (change of hunting legislation). Their renaissance was supported by numerous translocations and reintroductions. A swift increase in all wild ungulate populations – which is still continuing for roe deer, red deer and wild boar in many regions – was the result. The ecological recovery was facilitated by industrialisation, which drew people away from rural areas. As a consequence, the number of goats and sheep in the Alps declined drastically in the first half of the 20th century.

All these factors prepared the ground for the return of lynx to the Alps.

Today, the Alpine Lynx population consists of several occurrences, all originating from reintroductions in the 1970s: Switzerland 1970–76 (Breitenmoser et al. 1998), in the Dinaric part of Slovenia 1973 (Cop & Frkovic 1998) and Austria 1977–79 (Huber & Kaczensky 1998). There were also several attempts to initiate the reintroduction of lynx into the German Alps but none of the projects could be carried out because of very controversial attitudes towards the species and because of competition between institutions (Kaczensky 1998).

The strongest population is currently in the north-western Alps of Switzerland. Although lynx immigrated into neighbouring countries (France, Italy; see below) the forty years since the first releases have not allowed establishing a continuous population throughout the Alps.

3.2 Present status and distribution of the Alpine lynx population

The total population of lynx in the Alps is still small and endangered according to the IUCN Red List assessment (IUCN Standards and Petitions Subcommittee 2014). Kaczensky et al. (2013a) have assessed the large carnivore populations across Europe, based on the most recent data available. They have listed the Alpine lynx population as EN(D), meaning that the population is Endangered under the criterion D (total population size smaller than 250 mature individuals). The population was considered stable or slightly increasing in Switzerland, and stagnant in Italy, France, Austria, and decreasing in Slovenia, and the conclusion was that “the observed rate of development will most likely not allow for a natural fusion of the western and eastern Alpine populations within the next decades”.

The Alpine lynx consists today of five relatively isolated subpopulations (Molinari-Jobin 2010). They are slowly recolonising the Alpine region and their status has been studied in varying detail in the respective countries. Over the past 10 years, they have increased their area of presence by around 6,000 km² or 50%, mainly after a translocation in Switzerland (see below). However, the population size remained more or less the same. In 2011, the number of lynx estimated for the entire Alpine region was between 130 and 180 individuals.

Table 3: Lynx abundance in the Alps in 2001 and in 2011 (mature individuals). Sources: von Arx et al. (2004), SCALP (2012), Kaczensky et al. (2013a).

Country	2001	2009–2011	2011*	Trend 2006 –2011
France	single individuals	15–20	13**	West: slight increase
Italy	10-13	10–15	10-15	
Switzerland	70	100–120	96-107	
Liechtenstein	0	0–2	0	
Germany	0	0–1	0	East: decrease
Austria	20	6–12	3-5	
Slovenia	10	5–10	few	
Alps	~120	136–180	~130	

* estimates in Kaczensky et al. (2013a). **extrapolated from densities of the Jura population.

For the Alpine lynx population, the most important area is in the north-western Alps (western Switzerland), followed by north-eastern Switzerland and the south-eastern Alps (Italy and Slovenia). Both populations are the result of reintroductions in the early 1970s with very few founder animals, and both populations show today a high inbreeding coefficient. Two other smaller nuclei lie in the Chartreuse (France) and the Kalkalpen region (Upper Austria). However, only in four areas reproduction has been reported: north-western Swiss Alps, Friuli, north-eastern Switzerland and the Chartreuse region (Molinari Jobin et al. 2010a, b). More recently, reproduction also occurred in the Kalkalpen (Fuxjäger 2014). There is no permanent lynx presence with reproduction between or outside these areas, and even single confirmed observations are rare (Molinari-Jobin et al. 2010a, b).

In Austria nine wild lynx from the Carpathian Mountains were reintroduced in Styria between 1977 and 1979 (Huber & Kaczensky 1998), but the reintroduction failed. Recent observations concern lynx that immigrated from the Dinaric population or the Bavarian-Bohemian population (in the east) or from eastern Switzerland (in the west). The population in the Kalkalpen National Park consisted of a male which settled in the area in 1998 (Kaczensky et al. 2013c). A female from the Swiss Alps and a female and a male from the Jura Mountains were translocated to the Kalkalpen National Park in 2011 and 2013; both females have already reproduced (Fuxjäger 2014; Nationalpark Kalkalpen 2011a, b). Outside the Kalkalpen, two camera-trap photos were taken in 2009 by hunters of two individual lynx in two different regions of Salzburg, from where no other signs (not even unconfirmed) were known (Fuxjäger et al. 2012).

Overall, the French Alpine lynx sub-population was assessed to be stable with a regular population range of less than 1,350 km² and a population size of not more than 10–15 resident adults (Marboutin et al. 2012).

Besides a few unconfirmed direct sightings and rumours there was no confirmed evidence of lynx presence in the German Alps (Wölfl & Kaczensky 2001, Wölfl 2006, Wölfl & Wölfl 2012). The nearest lynx sub-populations to the German Alps are found in north-eastern Switzerland (distance 70 km) and in Slovenia (distance 180 km), besides the population in the Bavarian-Bohemian Forest, which is however separated from the Alps by open agricultural land.

The Italian Alps were naturally recolonised in the 1980s by individuals from the reintroduced populations. However, the initial positive trend was soon reversed and population estimates decreased from 21 individuals in 1995 with observed reproduction (Ragni et al. 1998) down to less than 15 in 2009 with no signs of reproduction (Molinari et al. 2012). In April 2014, a male and a female lynx were translocated from Switzerland to Tarvisio in the Julian Alps in order to reinforce the south-eastern Alpine/Dinaric lynx population (Molinari-Jobin 2014).

The first observations of lynx in Liechtenstein occurred in January 2004 and January 2005 (Fasel 2006). In March 2013, there was a visit from a female lynx radio-collared in the canton of Grisons (A. Ryser, pers. comm.), however, no lynx settled in the country so far.

The Slovenian lynx population is divided between the Dinaric and the Alpine populations (Kos & Potočnik 2013). The Jesenice – Ljubljana – Trieste highway marks the border between the two populations. The majority of the Slovenian lynx belong to the Dinaric population. During 2000–2004 a total of 30–50 lynx were estimated for Slovenia, of which 15 in the Alpine part (Koren et al. 2006). Estimates place the current population at 15–25 individuals, with about 5–10 individuals in the Alpine region and 10–15 in the Dinaric Mountains in southern Slovenia (Kos et al. 2012). In addition, no reproduction had ever been recorded in the Slovenian Alps up to then (Potočnik et al. 2009). The population of lynx in the Alpine region has further decreased to few (2–3) individuals (R. Černe pers. comm.).

In the Swiss Alps, the lynx population is part of the western subpopulation and occurs mainly in the north-western and central regions of the country. Between 2001 and 2008, 12 lynx from the north-western Alps and the Jura Mountains were translocated to the north-eastern Swiss Alps to create a new population nucleus and hence to contribute to the expansion of the species especially since spontaneous long distance migrations are rare. The population in Switzerland currently forms the largest subpopulation of lynx in the Alpine region (von Arx & Zimmermann 2013) with an estimated population of 96–107 independent individuals (von Arx & Zimmermann 2013). Signs of reproduction were found in the north-western region between 2000 and 2004 and between 2005 and 2009 with reports of juveniles each year in that region as well as in the north-eastern and central Alps (von Arx & Zimmermann 2013).

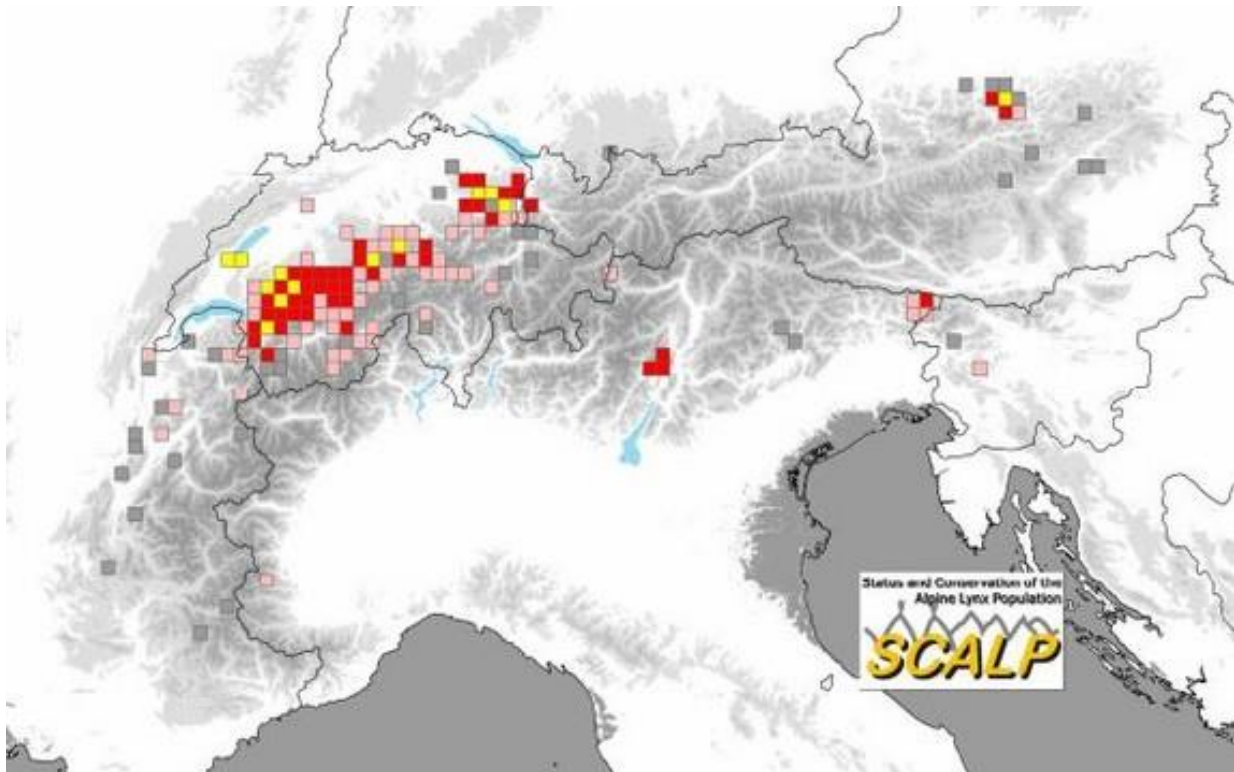


Fig. 2: Lynx distribution in the Alps 2012 based on a 10x10 km grid; yellow cells = cells where reproduction was reported from, red cells = C1, cells with hard fact records, pink cells = C2, cells with confirmed records, grey cells = C3, cells with unconfirmed record (SCALP 2012).

3.3 Diet and predation of lynx

The main prey of lynx in Europe are small to medium-sized ungulates (Nowicki 1997). Wherever roe deer are abundant, they form the staple food, followed in the Alps by chamois. This basic pattern was observed e.g. in Switzerland where these two prey species comprise up to 90% of the lynx diet (Breitenmoser et al. 2010) and in the French Vosges (Herrenschmidt & Vandel 1989). Where roe deer and chamois are either rare or even lack completely, red deer can function as secondary or even primary prey species, e.g. in Italy (Molinari 1998), Austria (Gossow & Honsig-Erlenburg 1985) and the Dinaric mountains in Slovenia (Krofel 2006). Other prey species may include foxes, hares, marmots, edible dormice, and (mainly in Scandinavia) tetraonids (Nowicki 1997, Breitenmoser & Breitenmoser-Würsten 2008, Krofel et al. 2011). Livestock depredation by lynx is generally low (Kaczensky et al. 2013a). Between 2006 and 2011, only 7 to 47 sheep were predated on per year by lynx in the Swiss Alps (von Arx & Zimmermann 2013). A total of 317 depredation cases have been recorded in the Slovenian Alps since 1994, but none since 2011 (M. Jonožovič, pers. comm.).

Depending on the size of the prey, lynx can return from one to seven consecutive nights to feed on their kill (Breitenmoser & Breitenmoser-Würsten 2008). Generally, lynx consume their prey fully so that the skeleton, skin, head, legs, stomach and intestines are all that remains (Capt 1992). Domestic sheep or goat kills are often abandoned before they are completely consumed because the cadavers are removed or the lynx is disturbed by the presence of people. Average daily consumption of meat was estimated to be 2 kg with a maximum of 3.0-3.5 kg (Haglund 1966, Bufka & Cervený 1996). The yearly consumption rate for lynx in Switzerland, based on radio-telemetry studies (Breitenmoser & Haller 1987, Haller 1992, Jobin et al. 2000, Molinari-Jobin et al. 2002), was estimated to be 56 ungulates (roe deer and chamois) for an adult male lynx, 57 for subadult lynx, 59 for solitary females, and 72 for females with cubs. So considering the proportion of the social categories in the lynx

population, this would come on average to about 61 ungulates per independent lynx and per year (Breitenmoser & Breitenmoser-Würsten 2008).

Predation impact of lynx on ungulates

The effect of predation on roe deer on a European scale was found to be weaker the more productive the environment was (Melis et al. 2009). However, under certain conditions, depending e.g. on the population status of predator and prey, on the recolonisation state (e.g. immigrating predators), and on other important mortality factors (e.g. winter mortality or human-caused mortality), lynx can have a significant impact on a local roe deer population.

The longest observation series to assess the quantitative impact of lynx predation for the Alps are available for Switzerland (Breitenmoser et al. 2010). The observed roe deer mortality caused by lynx predation (based on the assumed local abundance¹³) varied substantially (Breitenmoser et al. 2007). Indeed, the extreme values (9 and 63% of the known roe deer mortality, respectively) came from the same study area in the north-western Alps about 15 years apart. Haller (1992) observed a strong predation on roe deer in a high valley in the central-western Alps (Canton of Valais) shortly after the recolonisation by lynx. A sudden drop of the roe deer population was also observed in Central Switzerland (Canton of Obwalden) about 10 years after lynx had been reintroduced (Breitenmoser & Breitenmoser-Würsten 2008). Such observations were attributed to the lack of vigilance and behavioural adaptation of roe deer after the recolonisation by lynx (Breitenmoser & Haller 1993). However, another period of strong predation impact was observed in the years 1997–2000 in the north-western Alps, where lynx had been present for almost 30 years. This experience – although only a case study – illustrates the potential predation impact and the importance of cofactors (anthropogenic and climatic factors) influencing the predator-prey system and should be considered in a wildlife management system in the Alps with large carnivores present.

In the late 1980s and early 1990s, probably as a consequence of a series of mild winters and low winter mortality, the roe deer population in the north-western Alps increased, followed by a numeric response (a population increase with a certain time delay) in lynx (Fig. 3a). The growing roe deer population had also triggered an increasing human hunting pressure (Fig. 3b), demanded for by the foresters. After about 1995, the roe deer population started to decline, first slowly and then faster, causing a reduced hunting bag, as the hunters were no longer able to fulfil the quota. During this time, the lynx population still increased, and the predation impact reached its peak in the years 1997–2001. Lynx were in these years responsible for about 60% of the known local mortality in roe deer, besides hunting and “Fallwild”, and about 33% in chamois (Breitenmoser & Breitenmoser-Würsten 2008). Lynx maintained a rather high predation pressure on roe deer in spite of (or as a consequence of) part-switching to other prey, namely to chamois and more obviously to sheep (Fig. 3a).

¹³ Wild ungulate abundances are notoriously hard to measure and usually suffer from large uncertainties. All numbers that then are estimated from such abundances therefore have large uncertainties as well.

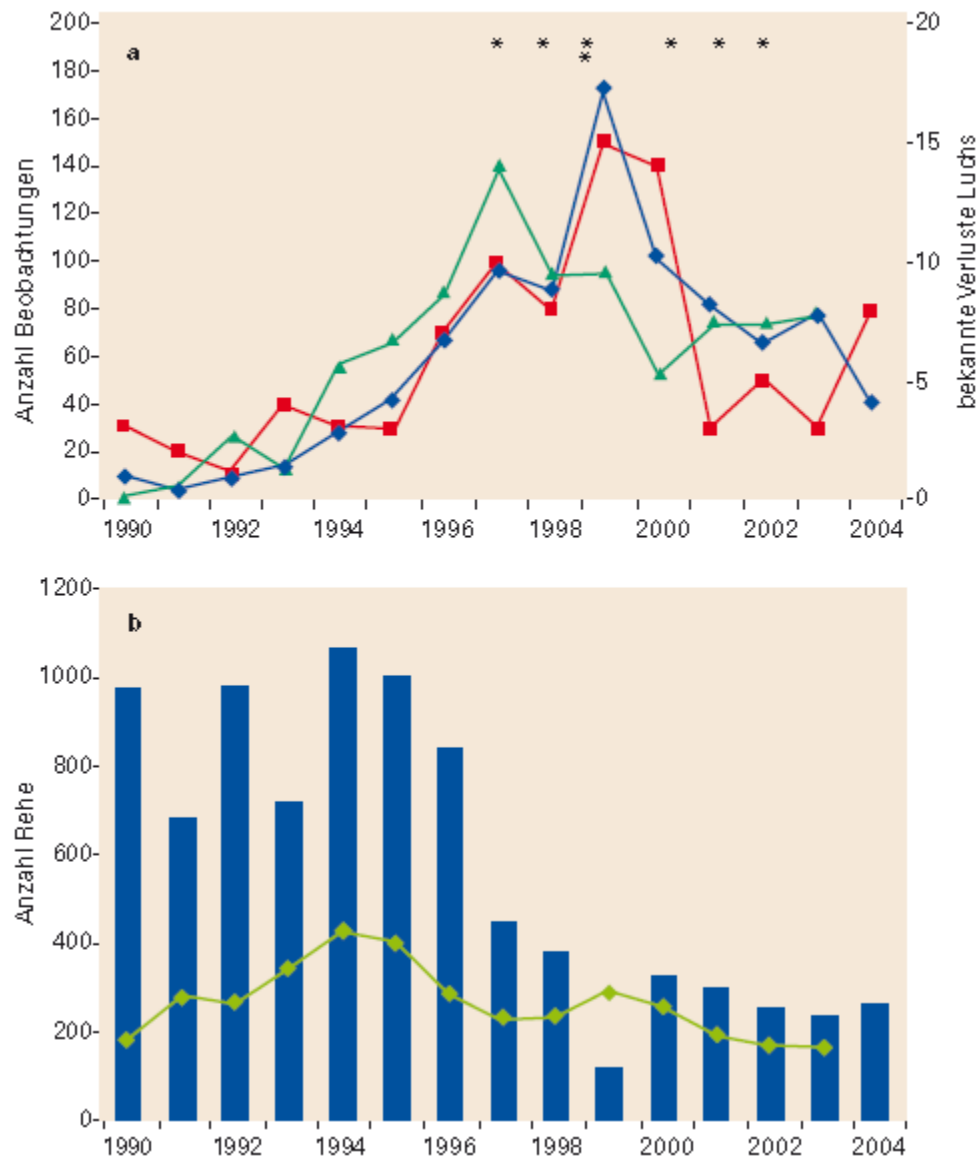


Fig. 3: Development of the lynx population (a) and the known roe deer mortality (b) in the north-western Swiss Alps 1990–2004. After 1992, the number of chance observations of lynx (a, green curve, left y-axes), the known lynx mortality (a, red curve, right y-axes) and the number of attacks on livestock (a, blue curve, left y-axes) steadily increased, indicating a growing lynx population. In the early 1990s, the hunting bag of roe deer also increased (b, histogram), parallel to a slight increase of the number of roe deer killed in traffic accidents in the same area (b, green curve). After about 1996, a drastic decline in the roe deer population was observed, illustrated by a drop of the hunting bag and a decreasing number of traffic victims. After a “lynx peak” in 2000, the lynx population dropped, too. In these years, 8 lynx (a, asterisks) were removed as stock raiders (source: Breitenmoser & Breitenmoser-Würsten 2008).

After the peak years and the crash of the local roe deer population, lynx showed a negative numeric response, but its importance cannot be estimated, as it was strongly supported by “management measures”, including the lethal removal of stock raiders, the translocation of 9 lynx in the years 2001–2003 into the eastern Swiss Alps, and an increase in illegal killings of lynx (Breitenmoser & Breitenmoser-Würsten 2008). In winter 1998/99, the local abundance of lynx was estimated at 2.6 independent individuals/100 km², and it dropped to 1.0 lynx/100 km² in winter 2001/02 (capture-mark-recapture estimations based on camera trapping; Laass 1999, 2002). In 2000, roe deer hunting bags for the canton of Bern (not just the study area) have already recovered again and reached almost the level of the early 1990s where they have stabilised (BAFU 2014). Meanwhile, lynx

densities have nowadays stabilised at around 2 independent individuals/100 km² (Zimmermann et al. 2014).

Both, the increase and crash of the roe deer population seemed to have been a consequence of mild and harsh winters, respectively. Winter mortality is a driving force of roe deer population dynamics in the Alps. But the case study demonstrates that lynx can show a considerable numeric response and that the combined impact of predation and hunting can strongly impact roe deer abundances if the effect of predation and the population dynamics of predator and prey are not understood and considered in wildlife management decisions.

3.4 Wild ungulates

3.4.1 Wild ungulate availability

The existence of a sufficient prey base is a key factor determining the successful return of large carnivores (Breitenmoser 1997). Populations of all wild ungulate species have been increasing over the past decades and continue to do so in many Alpine regions except for the chamois. Some countries make regular records of wild ungulate population sizes available (but often do not state census methods clearly), but others like Austria do not (Reimoser & Reimoser 2010). Hunting bag data were the only data sets almost consistently available across the Alpine countries. Of course, data on hunting bags show clear weaknesses, e.g. not being linked with the real hunting effort invested. In Bavaria for example, hunting efforts to reduce ungulate numbers were raised considerably over the last 20 years in order to decrease browsing impact on forest regrowth. Nevertheless, the existing data on population numbers and hunting bags were used to indicate the development of large herbivores and differences between the Alpine countries. More detailed population numbers and hunting bags are listed in the RowAlps report objective 1.¹⁴

Red deer have naturally recolonised the Alps, helped by reintroductions. Numbers are still increasing across the Alps according to censuses and hunting bags, with an especially strong increase of hunting bags in Austria. Hunting bags in the Alpine districts of Bavaria appear to be rising again as well, after experiencing an initial sharp drop by approx. 25% in the late 1980s followed by a slight further decrease for the next 15 years.

Roe deer are abundant and widespread across the Alps. Hunting bags appear to be still increasing in Austria and the Alpine districts of Bavaria. In the other countries they appear to be rather stable.

Wild boar hunting bag numbers are fluctuating strongly in some of the countries, with wild boar generally expanding their range and hunting bags increasing. In fact, the data compiled in the RowAlps report objective 1 show for all countries the highest hunting bags for wild boar for the most recent years.

Chamois are widespread across the Alps, but trends differ. Hunting bags in France continue to rise, while they stagnate in Bavaria and Slovenia. Meanwhile, in Switzerland and Austria, hunting bags have decreased by about a third since the early 1990s.

¹⁴ Breitenmoser et al. 2015. The recovery of wolf *Canis lupus* and lynx *Lynx lynx* in the Alps: Biological and ecological parameters and wildlife management systems. RowAlps Report Objective 1. KORA, Muri bei Bern, Switzerland. 276 pp.

3.4.2. Wild ungulate management

Red deer and roe deer are the most widely distributed ungulates across Europe and the Alpine range; along with wild boar they compose the most important game species (Linnell & Zachos 2011). These populations recovered from a net decline in the 19th and 20th centuries due to widespread unregulated hunting (Putman 2011). Management practices such as regulated and selective hunting practices, increasing migratory corridors and habitat connectivity, reduction in habitat fragmentation and protection of habitat, but also reintroductions, reinforcements and artificial feeding have led to an increase and recently stabilisation of these populations. In many regions of Europe, wild ungulates are so abundant today that management practices include measures to reduce damage to crops and forests and prevention or mitigation of diseases. Hunting is the most important management practice and is used in many countries to control populations and hence limit damage to agriculture and forests (Putman 2011). Culling of wild ungulates is widespread across Europe and is largely linked to the claims of agriculture, forestry and transport sectors (Morellet et al. 2011).

In spite of these challenges, few countries have established robust long-term census system to monitor ungulate populations. Direct and indirect censuses are the most commonly used methods to monitor ungulate populations. Direct census methods may include capture-mark-recapture method (Switzerland), open hill counts (Switzerland), animal vocalisations (Italy), spot lighting (Italy, Switzerland) and drive counts (Italy, Switzerland) (Morellet et al. 2011). Estimates from indirect methods use faecal samples, animal vital rates (France), snow tracking (Switzerland) and habitat quality (France, Slovenia) among several other sampling methods (Morellet et al. 2011).

Wildlife in the Alpine countries is managed through legal and practical means such as protective laws and selective hunting. Legislation operates at different levels (national, regional, provincial, etc.) across Europe. One generality however, exists across European countries: game does generally not belong to the land owner (Putman 2011). Game belongs to everyone or no one – *res communis* or *res nullius*. In the case of *res communis*, the state can either sell hunting licenses or allocate the sale of hunting licenses to individuals or hunting groups and do not involve landowners in this aspect (e.g. Italy, Slovenia¹⁵, Switzerland). In the case of *res nullius*, hunting rights belong to the landowner who allocates licenses while the state has the right to determine management goals (e.g. Austria, Germany, France; Putman 2011).

Although hunting seasons in European countries should ideally be determined based on the ecology and natural history of the species that are hunted, it is currently not the case in several countries (Apollonio et al. 2011). Factors that should ideally be taken into account when determining a hunting season include the period of rut, pre-parturition and post-parturition. These are important factors as hunting during these key moments can disrupt reproduction and have a negative impact on the population. Hunting during periods of late pregnancy can also be negatively perceived by the non-hunters with regard to ethical concerns. Culling adult females with young can result in the death or loss of fitness of young animals still dependent on their mothers. Many European countries allow the hunting of animals during these three critical periods during the breeding season for species such as red deer, roe deer, chamois and wild boar (Apollonio et al. 2011).

¹⁵ In Slovenia, the state is the legal owner of game according to the Environmental Protection Act of 2004.

Table 4: Comparison of management systems across the Alpine countries (adapted from Putman 2011), showing strong state controlled management practices on the left and individual landowner management types on the right.

	Impose/determined by state (National or regional authorities)	Proposed by land owners associations/ Hunters' associations, approved by State	Proposed by landowners associations/ Hunters' associations or equivalent voluntary
Game management district/group	Switzerland, Slovenia, France, Austria	Germany, Italy	
Management objectives	Switzerland, Slovenia, France, Austria	Germany, Italy, Austria	
Management Plan	Switzerland, Slovenia, France	Germany, Italy, Austria	
Quota/Cull Targets	Switzerland, Slovenia, France Cull carried out by game wardens	Germany, Italy, Austria Individual licenses allocated (per animal)	Global quota allocated to leaseholders
Global Quota/ Individual licenses	Cull carried out by State hunters Switzerland (Canton of Geneva), France	Individual licenses allocated (per animal) Switzerland, France	Global Quota allocated to leaseholders Slovenia, Germany, Italy, Austria

3.5 Livestock husbandry

Livestock husbandry is much less important for the lynx than for the wolf therefore more detailed information on livestock husbandry can be read in the wolf recommendations.

Sheep are the most important and most abundant domestic victims of predators in the Alps (Kaczensky 1996). Therefore the chapter focuses not exclusively but very much on summered sheep.

3.5.1 Development of livestock husbandry and pastoral systems in the Alps

Livestock husbandry has largely influenced Alpine societies and traditions. After a peak in the 19th century, the agricultural crisis as a consequence of industrialisation, which drew people away from remote areas, led to the abandonment of many Alpine pastures. The importance of sheep declined around 1830, when the domestic wool production lost its competitiveness to wool from abroad and cotton. Sheep husbandry is today promoted to prevent that remote pastures in the Alps are grown over by forest. Goats have today totally lost their former economic significance in the mountains. Only the financial support in the frame of subsidies (since the 1980s) attenuated the trend of a reduction in numbers of summered livestock and the variability of summered livestock. Nevertheless the species of livestock can still change (e.g. sheep instead of cattle or horses, sheep instead of goats and so on; Ringler 2009).

In the past 100 years numbers of summered sheep and goats have significantly decreased in the northern parts of the Alps (A: decrease to 1/7 of the numbers between 1927 to 2008; D: decrease to 1/2 of the numbers between 1950 to 2003; FL: decrease to 1/8 of the numbers between 1977 to 2003) whereas in Switzerland and in Italy summered sheep and goat numbers decreased only slightly (around 15%) and increased heavily in Slovenia (up to 4 times the number between 1923 to 2003) and France (additional 43%; Ringler 2009).

3.5.2 Mountain pastures and pastoral systems today

In absolute figures the surface of alpine pastures is the highest in France (more than 2 million ha), the number of pastures however is the highest in Austria (more than 13'000). Today, between 5 and 50% of the Alpine area are pastures, depending on regions.

Pastoral systems and practices vary depending on the country, traditions and type of terrain. There are three main types of mobile sheep herding: nomadic, transhumance (i.e. seasonal change of grazing areas) and the alp system. On each alp other responsible bodies, managers and partners are engaged and make the mountain pasturing and pastoral system in the Alps a diversified and complex system.

3.5.3 Present figures and distribution of livestock

Presently ca. 1.5 million sheep are distributed on Alpine pastures across the Alps. The trend in livestock husbandry varies (see above). Cattle are still the most abundant livestock species summered in the Alps (ca. 2 million), but sheep are the most abundant in remote areas. Sheep are often an alternative to cattle for farmers with less time and personnel.

The differences between numbers of animals and the species in the Alpine regions are high. More than 50% of the alpine sheep are in the French Alps. Sheep pastures are generally dominant in the southwestern Alps and are generally stronger in the western Alps, than in the eastern Alps. Mixed regions with sheep and cattle are widespread in the Isère, Alpes Maritimes, Piemonte, Wallis, Slovenia, Werdenfelser Land and parts of Tyrol. The regions in Upper Austria and Bavaria are currently the regions with the fewest sheep in the Alps. Goats play still a role in Haute Savoie, Grisons, Ticino, in the Fribourgian Alps and finally around the Upper Italian lakes.

3.5.4 Livestock protection measures

With the disappearance of large carnivores from their historical range, the traditional livestock protection methods were also abandoned. It was a common practice in the past, when predators were rare, to leave large herds of livestock unattended in the mountain pastures, in countries like France, Switzerland and the Alpine region of Slovenia. However, the return of large carnivores, in particular wolves requires a return to traditional pastoral ways and guarding which can be an expensive option. In most Alpine countries, the greatest number of attacks occurred during the summer season when livestock graze on alpine pastures (Anonymous 2010). The most effective protective measures against predation include guarding dogs, electric fences and the presence of a shepherd.

In order to implement effective protection measures against large carnivores, the current livestock management system is of major importance. It is e.g. easier to implement protection measures if personnel is available on pastures, if the pastures are furnished with infrastructure for shepherds, if flocks or herds are rather large and held together on a specific surface area (facilitates the integration of livestock guardian dogs).

Current monetary and management measures

The rationale for the compensation is that the legal protection and the recovery of the large carnivores are a societal desire, and that therefore society (hence the state) should pay for losses of those who economically suffer from the return of these animals.

In all Alpine countries losses of livestock to large carnivores are reimbursed by the government or associations (e.g. hunting). A compensation system has been adopted in France, Italy, Switzerland, Germany, Austria and Slovenia. The compensation techniques vary in the different countries depending on the socio-economic status of the country as well as culture and traditional practices (Boitani et al. 2010). In the Alpine countries, most of the compensations are monetary in nature. Except for the case of some provinces in Austria, this compensation is part of a pre-arranged government programme. These programmes include the examination of the dead domestic animal and determination of cause of death by an expert. The “typical” case of lynx depredation is rather easy to identify, whereas it is more difficult to distinguish between attacks of wolves or of stray dogs (Molinari et al. 2000, Fico et al. 2005). If confirmed that the animal was attacked and killed by a lynx or a wolf, the farmer or livestock owner is entitled to a predetermined sum of money which is generally based on the breed and age of the animal.

Current prevention and compensation of predation by lynx on livestock per country

In the Austrian “lynx areas”, along the Austrian-Bohemian-Bavarian border (outside the Alps) and around the Kalkalpen NP, sheep farming is a relatively unimportant activity. In recent years, there have been no cases of livestock depredation in this region. In the case of damages, a “voluntary” (no legal base for compensation) reimbursement would be available in most provinces and is covered by the hunting insurance of hunting associations. The predation of wild ungulates is the main source of the conflict between lynx and hunters in Austria.

Depredation cases of lynx on livestock in the French Alps are low. The average number per year of depredation cases attributed to lynx in the whole of France between 2000 and 2011 was 72 and the compensation cost amounted to less than 20,000 € per year (Marboutin 2013b).

Currently, the state of Bavaria has provisions for compensation payments for cases of lynx depredation. All kills have to be assessed and documented by trained personnel.

The main conflict over lynx in Bavaria is with hunters with regard to the predation of wild ungulates.

All lynx depredation cases in Slovenia are compensated by the government (Kos & Potočnik 2013). Compensation costs between 1995 and 2014 varied from 0 –13,225 €, 0 € in 2013 and 2014 (M. Jonozovič, pers. comm.). In some areas, livestock are brought back to stables or fenced in at night to reduce the risk of attacks in the Slovenian Alps (AGRIDEA 2014b).

In 2013, there were 21 cases of depredation in the Swiss Alps. The compensation of losses of sheep and goat between 2006 and 2011 amounted to 6,500–25,000 CHF per year. Killed livestock have to be examined by an official and trained person and are compensated up to 100% if predated by lynx. If a lynx kills more than 15 sheep within a given area per year, the canton can ask for permission to remove the individual. The last such case was registered in 2003.

3.6 Perception of interest groups and individuals regarding large carnivores

The following chapter does not differ between the large carnivores. The chapter is based on the report for objective 2 of the RowAlps project, which was developed by working group 2.

Already when talking about the spirit of WISO at the very beginning of this report, the hypothesis was, that *sustainable wildlife management can't ever be a question of purely scientific knowledge – far away from it: Sustainable wildlife management has to be an expression of a will, how to deal with our wildlife species - by taking into account, by balancing and by harmonising ecological, economical and socio-cultural interests: A decision of all stakeholders involved is required - or let's just say, a decision by society* (Näscher 2009).

Therefore an analysis of the social framework and entry points for a successful management of conflicts has been required for these management recommendations. The objectives of working group 2 of the RowAlps project were to describe tolerance mechanisms for lynx and wolf among various land-user groups, and to identify factors that influence tolerance as well as potential measures to alter these factors. To reach these objectives,

- a meta-analysis of existing social science research on large carnivores across Europe was conducted by the Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft (WSL) and
- interviews and workshops with experts in the fields of hunting, alpine farming and social science research on LC were conducted by the Technische Universität München (TUM), Chair of Forest and Environmental Policy.

Due to limited resources the approach had some limitations which mainly are:

- Due to the qualitative methods used, the interpretation of the interviews and workshop outcomes are the results: a separation of the results and an interpretation of those results are not possible as in many other scientific investigations.
- Land users were interviewed only in Bavaria and then only those from the agricultural sector, as there were no resources available to working group 2 to conduct further interviews with hunters or land-users in other Alpine countries.
- Only one of the two originally planned hunting workshops was held because of a lack of participants from the western Alps section.
- All authors live and work in Germany. Although they interviewed experts from nearly all Alpine countries, their analysis is, by their account, undoubtedly influenced by the German situation in which they were socialized.

Every actor concerned with the (re)occurrence of large carnivores has his or her own view of both the central problems and the main goals of large carnivores management.

These largely implicit framings of the problem or the issues to be addressed influence the entire management process (IRGC 2005). Three different types of problem framings were identified: The population dynamics of large carnivores, the direct interactions between large carnivores and those affected; and the social and political conflicts. All three problem framings are influenced by the individual perception of large carnivores. In reality, a conjunction of these problem frames will be the basis of all large carnivores management.

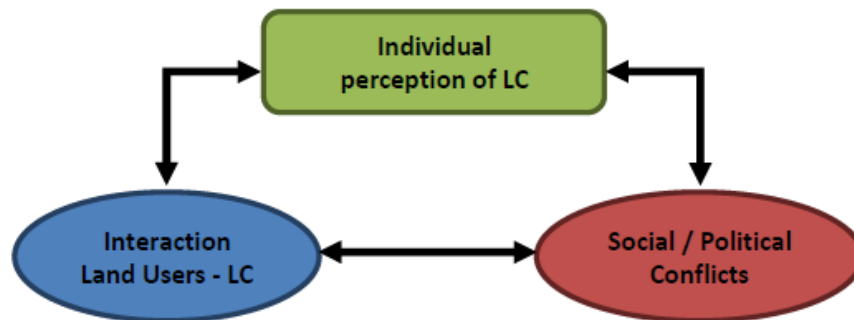


Fig. 4: Interdependencies among the various levels where factors influencing attitudes towards LC are settled.

3.6.1 Direct interaction of large carnivores and those affected

On the level of direct interaction, six main factors influencing the effect of the presence or imminent return of large carnivores on Alpine farming systems were found.

1. Financial burden / opportunity costs

Farmers evaluate the state subsidies for flock protection on two different levels. On the one hand, they want all direct expenses for flock protection covered by the state. On the other hand, the working capacity of the farmer is a restricting factor for flock protection. The farmers expect that also the opportunity costs are covered by the state.

2. Farming practices

Different types of farming practices (e.g. free ranging vs. directed grazing with the help of shepherds or fences; grazing only during summer or also in winter; herd size) require different types of flock protection. Especially in the case of the more extensive forms of grazing, protecting flocks in the presence of large carnivores is extremely difficult in the view of many farmers.

3. Type of animals

It is well known that sheep and goats are much more vulnerable to predation from large carnivores than cattle. A special focus should be put on ancient breeds which are highly subsidized within the Common Agricultural Policy of the European Union (CAP) and also often have a high non-monetary value for the farmer.

4. Legal framework / grazing rights

Legal regulations and old grazing rights sometimes complicate both the implementation of flock protection measures and the reorganization of grazing systems.

5. Natural conditions

Natural conditions, such as the extent and density of forest, local weather conditions and topography, influence the likelihood of damage to livestock due to large carnivores.

6. Tourism

Flock protection measures using livestock guardian dogs (LGDs) might lead to conflicts with hikers and bikers, especially in regions where tourism is important.

These six influencing factors can be summarized by the concept of vulnerability. The concept of vulnerability is not meant to be a concept of zoning, but rather it is a strategy to set priorities for efforts to mitigate conflicts.

Influencing factors for the vulnerability of Alpine farming regions are the historical development, on the basis of natural and cultural conditions, actual land use policies (subsidies for shepherds, subsidies for rare breeds (often sheep and goat), less subsidies for free ranging grazing (example Switzerland)) and large carnivores management (feasibility of flock protection).

Additionally, some currently practiced methods of hunting and ungulate management will be challenged by the return of large carnivores. The impact of large carnivores on both the size and the behaviour of ungulate populations must be considered in hunting and forest management planning. For example, various methods of feeding ungulates (such as efforts to influence their spatial distribution to reduce browsing effects on silvicultural crops) will be more problematic if large carnivores adapt their hunting habits to take advantage of accumulations of ungulates caused by feeding stations and winter enclosures. Adaption to the return of large carnivores may be more demanding in countries where such types of winter feeding are common than in other countries.

3.6.2 Factors in social and political conflicts with large carnivores as a trigger for conflicts

On the social and political levels, the conflicts detected could be described as mainly power struggles and value conflicts. Here, large carnivores are often only one issue within an already existing larger conflict. The distribution of power among the various actors in such conflicts has changed in the course of the reoccurrence of large carnivores. The following conflict constellations were found:

1. Urban – rural (Power struggle and value conflict)

This conflict constellation has no clear actor structure, and is displayed within public and political discourses. Land-use actors criticize the higher degree of influence that urban actors have on political decisions. On the discourse level, a clear difference in values is constructed, in which land-use actors are seen as having a use-orientated, anthropocentric image of nature, while the urban population are portrayed as viewing it more from an aesthetic oriented, ecocentric point of view. Also, the self-image of Alpine farmers differs from the image they have among the general public. Generally, both the general public and urban actors often criticize the negative impact of farming on the environment and the high level of subsidies. In return, farmers base the legitimacy of their practices and the subsidies they receive on their role as food suppliers.

2. Land-use actors – state (Power struggle)

The common conflicts here revolve around the subsidy system and legal regulations. Regulations that reduce the level of autonomy of land-use actors and increase the amount of control state agencies have are opposed by land-use actors.

3. Land-use actors – environmental NGOs (Power struggles and value conflicts)

The basis for the power struggle is the question of which group should have the power to make decisions about what occurs in the Alps, while the basis for the value conflict is the question of which value is more important: High levels of biodiversity and / or wilderness (environmental NGOs) or tradition and culture (land-use actors).

4. Horizontal / vertical conflicts between or within state agencies (Power struggles)

In most Alpine countries, the central conflict is a horizontal conflict between the ministries for agriculture and environment.

3.6.3 Interaction of both levels – social/political and direct interaction

The two levels of analysis are interconnected. Negative perceptions of large carnivores might result in a reduced willingness to adopt flock protection measures. An unsuccessful implementation of flock protection might increase political conflict. Political conflict influences individuals' perceptions of large carnivores and large carnivores' management. Nevertheless, we formulate the hypothesis that there is a correlation between the reason a particular actor is practicing animal husbandry and the level on which large carnivores management is or can be most successful. If the main reason for practicing animal husbandry is economical, work at the level of direct interaction between land users and large carnivores is most important. In regions where other reasons, such as tradition or cultural identity are more important, the resolution of social conflicts is crucial.

3.6.4 Management implications

The following chapter is focused on a land use perspective and mainly on agriculture. The results do not analyse nor focus on differences for single countries.

Preconditions for all paths of actions are that the social norms and values of farmers are obviously generally opposed to large carnivores:

- The extinction of large carnivores is perceived as a cultural achievement.
- Animals that are being bred are perceived as the “nature to be protected”.
- Conservation of the cultural landscape is a central justification for their position. Farmers disagree with the target of establishing wilderness in the Alps, for which large carnivores are perceived as a symbol (Caluori & Hunziker 2001).

A slightly different situation concerning social norms and values of farmers can be observed in parts of Slovenia and Italy, where farmers are more familiar with large carnivores because of the relatively long tradition there of living alongside them.

Management implications in hunting

Hunters have a more ambiguous view:

- On the one hand, there is a tradition of purposeful extermination or hunting of predators. Thus, some hunters still perceive the extinction of large carnivores in the Alps that occurred in the 19th century as a good and necessary end. On the other hand, the idea of game keeping is common and could be applied to large carnivores. For example, in Slovenia hunters actively reintroduced the lynx.
- Norms that guide hunting practices are very important (Schraml 1998, Stengeli 2014). These norms can be influenced by in-group communication.
- Large carnivores have a relevance as potential trophy animals.
- Especially in Germany, the perception is common that large carnivores, particularly wolves, will not have suitable habitat in such a densely populated country (Kaczensky 2006, Stengeli 2014).

Given that the main threat to LC populations is illegal killing, in general two aspects of this problem have to be addressed:

1. Accidental killing and the
2. encounter rate between hunters and LC (and thus, the concomitant potential that an illegal killing of a LC will occur).

Furthermore, stronger control on hunters by official bodies would be necessary in order to be able to enforce protection of LC. Game wardens like the “guardacaccia” in Italy or the “Wildhüter” in Switzerland are examples of ways to implement better on-site control of hunters.

Legal regulations and financial aid (e.g. in Switzerland hunters get a reduced hunting licence fee if they can prove that large carnivores are present in their hunting area) to the hunting sector will also need to be evaluated to determine if the outcome of these steering instruments hinders the goals of large carnivores protection. Hunting regulations should be analysed if the influence of the presence of large carnivores is considered. For example, hunting quotas are often not adapted to the special challenges of large carnivores presence.

Management implications in power distribution between political actors

Managing social conflicts requires an understanding of the relationships and the distribution of power between different actors in different countries. Comparing the position and power of interest groups and actors in the Alpine countries, it seems obvious that every country has its own tradition affected by its own unique institutional setting. The return of LC and the accompanying societal discussion might cause a change in the distribution of power among the institutions involved which will also either shift the existing lines of conflict or generate new ones. The following paragraphs summarize the political actors involved, likely changes in the distribution of power between them and the main drivers of the discussion about LC are described for each Alpine country.

Austria

In Austria, private land owners, state and public forest owners and hunting associations are considered to be the most powerful players. With the return of LC, especially wolf, land owners and hunting associations are expected to lose power, and the pressure other actors will be able to exert on them will increase. The eNGOs, the environmental authority and hunters whose main purpose in hunting is to stem the threat ungulates pose to forests will gain more influence in the field. The agricultural sector was judged as the main driver.

France

Due to the centralized political system in France, the agricultural, hunting and environmental authorities have the most power of the institutions participants identified as being involved in LC issues but also receive the most pressure from interest groups. Sheep farmers are land users, but often do not own the land they use, unlike most of their counterparts in other countries. This fact makes them a less powerful interest group in France than in other countries. With the return of the wolf to France, sheep farmers are gaining power and putting pressure on the authorities responsible for LC management. Environmental NGOs (eNGOs) have also become politically more important through their efforts to restrict traditional land-use practices (drive hunts) due to the danger they pose to the bears that are now present in the Pyrenees and hence exciting conflicts with the hunting association. The agricultural sector is perceived to be the main driver of the discussion regarding LC in France.

Germany - Bavaria

In Bavaria, private land owners and the organizations that represent them, such as the farmers' association, currently have the most power with regard to LC. Forest authorities (the forest ministry and the state forest administration) and the hunting association are struggling to influence land owners within an ongoing conflict about forest regeneration. With the return of LC, especially the wolf, both the farmers' association and the hunting association are expected to receive more pressure from eNGOs and environmental authorities. The agricultural sector was judged as the main driver of the discussion about LC.

Italy - South Tyrol

In contrast to France, land owners here are rather powerful. The "Landeshauptmann" (governor of the province) plays an equally important role as that played by the state government (Rome). Here, the hunting sector was listed as the main driver.

Slovenia

The Slovenian Forest Service (SFS) is in charge of hunting management, forest management and LC management. The fact that all of these tasks are undertaken by a single public body makes the influence of the SFS stronger than the forest agencies in the other countries investigated here. This could possibly help mitigate conflict. As a technical body that serves as a consulting entity to the Ministry for Environment and Farming, the University of Ljubljana is also perceived as a quite powerful actor that is for the most part not greatly influenced by other actors. Thus, the university has a greater influence on LC management than universities in other countries. With the return of LC, the pressure on the SFS is expected to rise, because the conflicts between land users (land owners, hunting association) and between land users and the SFS will intensify. The hunting sector was judged as the main driver of the discussion about LC, especially wolves.

Land-use practices like ungulate (game) and forest management are largely directed towards meeting economic goals. As ungulates are herbivores and browse on trees, forest regeneration is dependent on both ungulate density and forest structure (management). This implies that there are competing interests between the hunting sector (which is interested in high ungulate densities) and the forestry sector (which is interested in high levels of forest regeneration). In each of the different Alpine countries, one or the other interest prevails depending on the relative economic importance of the respective sectors.

Management implications in farming

In the view of the experts interviewed, prerequisites for livestock breeders tolerating large carnivores are:

- functioning flock protection measures and
- sufficient funds for financial aid and compensations.

Effective flock protection demands experience with different measures under different conditions to be able to recommend the most promising method to farmers given their particular situation. Numerous open questions about the effectiveness of flock protection methods still need to be addressed.

In terms of sufficient financial aid - for example, in cases where it is not clear if damage was caused by large carnivores or other predators - solutions that involve little bureaucracy and favour land users should be established. Central here is that compensation will continue to be paid, even if compensation costs rise tremendously. Furthermore, late or reduced payments must be avoided.

These are preconditions for establishing trust in and credibility for the state (agencies). In this context, processing of compensation payments through agricultural administrations is crucial. The distribution of compensation and financial aid via the established network is more promising than attempts to establish relationships between farmers and other government entities with which they have no existing relationships (e.g. environmental authorities). Farmers already have a relatively trusting relationship with agricultural authorities.

Agricultural funding must be adapted in the long term to eliminate contradictions, especially concerning the promotion of vulnerable livestock species (sheep) and inconsistencies between subsidies for extensive pasture management and flock protection measures (Meschnig 2014). In the Alps, rare breeds are often sheep or goat breeds. Thus, two biodiversity conservation goals – conservation of rare breeds vs. large carnivores protection – will have to be balanced.

Diverse synergies exist among farming methods on the one hand, which are adapted to be more suitable for a coexistence with large carnivores and pasture- and herd management methods on the other hand, that are adapted to promote biodiversity and animal welfare and are more ecologically sound.

To be able to effectively promote tolerance towards large carnivores and to find suitable solutions, the level on which conflict emerges (direct interaction or social / political) must be considered. And therefore it is crucial to be clear about the actual phase of large carnivores colonization that is taking place (as, for example, is used in Bavarian management plans; Phase 1: before return; Phase 2: occurrence of single animals; Phase 3: small population established; Phase 4: expanding population). Different phases demand different management measures, and every phase (appearance of an animal, establishment of pack etc.) must be immediately communicated to the land users.

Social conflicts are often the dominant ones, even where technical arguments are being used. A central entry point here is negotiating with the actors involved (Primm & Clark 1996; Majić et al. 2011). Preferably, this should be done before large carnivores enter a region, or at least before the first conflict occurs. Though it is tempting to adopt a “wait and see” attitude as long as there are no conflicts, or only relatively few, management of a conflict which has already escalated is much more difficult (Glasl 2002).

Especially in countries like Slovenia and Italy that have been forced to take cost-cutting measures due to the economic crisis, the risk exists that spending little or no money early on will mean either having to spend more money later or having to deal with a major conflict.

To what extent money should be spent on managing conflicts has to be decided, and the consequences of this decision have to be borne. In France, a discussion about the amount of money spent directly or indirectly on wolves popped up.

Such questions have to be worked out among the actors involved and communicated appropriately.

Nevertheless, even early intervention and commendable handling of conflicts (financial, communicative etc.) cannot guarantee peaceful coexistence everywhere. There could be situations where it will not be possible - particularly where extensive pasture management and large carnivores (esp. wolf) must exist side by side. In those cases, appropriate courses of action will have to be defined and communicated. (See Primm & Clark (1996) for the importance of understanding and working with the policy process.)

As it is unlikely that public communication will reach land users, it is suggested developing and establishing a communication concept with land user associations as the central communicator. Affected actors should be the first to obtain new information and have the opportunity to communicate this information to their own group. An effective manner of communication will have to be worked out with the actors themselves. Role models (collection of best practice examples, farms etc. with charismatic personalities where coexistence with large carnivores works) are needed that will be perceived as in-group and, therefore, accepted in the field. These role models will have to be well-financed and scientifically assisted. For a project to be seen as in-group supported action, comprehensive involvement of actors is necessary. Examples of projects that have involved agricultural actors are the Swiss “AlpFUTUR” project¹⁶ and the Austrian shepherding and flock protection projects. In our opinion, the best mode of operation is one in which the group charged with developing measures includes the actors that must implement these measures later.

Management implications for participation and communication

It is proposed to have an increased focus on management of social and political conflicts by:

- Implementation of participatory approaches of high quality.
- Minimize goal conflicts with land use regulations (e.g. high importance of the EU Common Agricultural Policy, hunting regulations have to consider LC presence)

Finally participation is very important when dealing with management of Large Carnivores. The participatory approaches have to be of high quality (whereas the criteria of this quality have still to be identified, e.g. fitting discussions to the level of decision making, Inclusion of all relevant interest groups and state agencies). And finally a further management implication is an increased focus on in-group communication (e.g. projects in collaboration with land use actors).

The following entry points for the social acceptance of wolf and lynx can be summarized:

1. Consideration of conflict level;
2. Negotiation with actors - for example, in participatory processes or model projects - with the goal of optimizing both flock protection and conflict management;
3. Development of a communication process with actors.

4 Discussion, interpretation and assessment of a future Alpine lynx population and main threats

4.1. Minimum viable population (MVP), ecological carrying capacity (ECC), and favourable conservation status (FCS) for the Alpine lynx population.

Concepts of population viability

Per definition, a viable population size lies somewhere between the ecological carrying capacity (ECC) and the minimum viable population (MVP). The ECC is the point in an unmanaged population where the birth rate and the mortality are at equilibrium. It may be temporarily exceeded, but then the mortality will surpass the birth rate and the population will steer towards ECC again (Mills 2007). The

¹⁶ <http://www.alpfutur.ch/index.php>

ECC is not static but may change over time due to changes in environmental conditions and/or resource management, which influence birth rate and mortality.

The lower end of the spectrum of a viable population size is given by the MVP. However, there is more than one concept of population viability:

- *Demographic viability* calculates the probability of extinction for a population of a given size within a specified number of years as a function of natality and mortality.
- *Genetic viability* concerns the long term persistence of genetic variation and evolutionary potential, and the avoidance of genetic impoverishment through inbreeding and genetic drift.
- *Ecological viability* refers to the interaction between a species and its environment. This encompasses both the needs, but also the effects of a species regarding its environment (Linnell et al. 2008). It is more a function of the ecosystem than of the species.

Despite many uncertainties about the exact ratio between the concepts, it is agreed that it usually takes a far larger population (e.g. by a factor 10) to maintain genetic viability and/or ecological viability than for demographic viability. In general, demographic and ecological viability are assessed at the population level, and genetic viability at the metapopulation or ecosystem level (Linnell et al. 2008). However, the concept of MVP is difficult to apply: scientifically, it is not possible to correctly determine a single minimum number of individuals that will secure long term survival of the population because of the inherent uncertainty and stochasticity in nature and management; and ethically, it is questionable to manage for a minimum number of individuals (Mills 2007).

Consequently, the EU Habitats Directive does not demand MVP as a target for species, but to achieve Favourable Conservation Status (FCS). The definition in Article 1 of the Habitats Directive says:

“The conservation status will be taken as ‘favourable’ when:

- *population dynamics data on the species concerned indicate that it is maintaining itself on a long term basis as a viable component of its natural habitat, and*
- *the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and*
- *there is, and will probably continue to be, a sufficiently large habitat to maintain its population on a long-term basis”* (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora).“

The guidance document “Assessment, monitoring and reporting under article 17 of the Habitats Directive” indirectly states that a population must be at least bigger than a MVP to be able to reach FCS. The upper limit is defined by what the potential habitat can support at an “optimum density” (i.e. ECC).

FCS is based on two major Favourable Reference Values (FRV) – the Favourable Reference Range (FRR) and the Favourable Reference Population (FRP) – according to the DocHab-04-003/03 rev 3 and the guidance documents. It is stated in the guidance documents that FCS is a positive goal, where the goal should be to make species status as favourable as possible, and not just to have passed a minimum benchmark.

Like any legal text, the directive text is not based on scientific definitions. This poses major challenges in its operationalisation per se, and especially for species as diverse as lichen and lynx. An interpretation for large carnivores was made by Linnell et al. (2008) in the “Guidelines for Population Level Management Plans for Large Carnivores in Europe”.

Operational proposal to define Favourable Reference Population

“[W]e suggest that favourable reference population be defined as the sum of the following criteria:

- (1) The population must be at least as large as when the Habitats Directive came into effect, and,*
- (2) The population must be at least as large (and preferably much larger) as a MVP, as defined by the IUCN criterion E (extinction risk based on a quantitative [Population Viability Analysis] with <10% extinction risk in 100 years), or criterion D (number of mature individuals).*
- (3) The population’s status is constantly monitored using robust methodology” (Linnell et al. 2008).*

A population can be considered as viable (i.e. at least MVP) according to the IUCN Red List if it reaches at least the category “Near Threatened NT”, which is not formally a threatened category¹⁷. This category is reached under criterion D with a population of 1,000 or more mature individuals in the population. However, if the considered regional population is connected to a neighbouring population to such an extent that immigration can have a significant positive effect on the demographic viability of the population and the sum of the populations (hence the metapopulation) reaches the benchmark, then the threat category for the regional population (hence the subpopulation) can be downgraded by one level; i.e. if two connected neighbouring populations exceed the benchmark of 1,000 mature individuals, the regional subpopulation is still considered as not threatened if it exceeds the next lower benchmark of 250 mature individuals (which would classify as “Vulnerable VU” in an un-connected population; Linnell et al. 2008).

Operational proposal to define Favourable Reference Range

Put simply, the Favourable Reference Range (FRR) is the area needed to contain the Favourable Reference Population. However, the issues of habitat quality, density (e.g. societal carrying capacity) and connectivity warrant consideration.

“As a result we generally recommend that Favourable Reference Range be considered larger than the area strictly necessary to support the Favourable Reference Population, and that it attempts to ensure (1) the continuity of distribution within a given population, and (2) the possibility for connectivity between populations” (Linnell et al. 2008).

Operational definition for favourable conservation status for large carnivores

“We [...] suggest that a population can be regarded as having reached FCS if it satisfies all of the following criteria;

- (1) ‘Population dynamics data on the species concerned indicate that it is maintaining itself on a long term basis as a viable component of its natural habitat’ (Article 1 (i)). We interpret this as implying that monitoring data indicate the population has a stable or increasing trend. We believe that a slight reduction in population size may be permitted if it is a result of response to changes in prey density or habitat quality that are not the cause of direct human action, unless conditions for derogations apply [...]. All segments of a population should have stable or positive trends, and not just the population as a whole. And,*
- (2) ‘The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future’ (Article 1 (i)). We interpret this as implying that the overall distribution of the population is stable or increasing. And,*

¹⁷ The ICUN Red List threatened categories are Vulnerable VU, Endangered EN, and Critically Endangered CR.

- (3) 'There is, and will probably continue to be, a sufficiently large habitat to maintain its population on a long-term basis' (Article 1 (i)). *We interpret this to imply that the quality and continuity of habitat should be sufficient, and have a stable or increasing trend. And,*
- (4) *The population size and range are equal to or greater than when the Directive came into force. And,*
- (5) *The Favourable Reference Population size has been reached. According to our proposal this will be set at levels greater than those regarded as being viable using the IUCN Red List criteria E or D. And,*
- (6) *The Favourable Reference Range has been occupied. And,*
- (7) *Connectivity within and between populations (at least one genetically effective migrant per generation) is being maintained or enhanced. And,*
- (8) 'Member States shall undertake surveillance of the conservation status of the natural habitats and species referred to in Article 2 with particular regard to priority natural habitat types and priority species' (Article 11) and 'Member States shall establish a system to monitor the incidental capture and killing of the animals species listed in Annex IV (a)' (Article 12.4). *These statements combine to indicate that the population should be subject to a robust monitoring program.*

Criteria 1-3 and 8 are taken from the text of the Directive, criteria 4 and 6 are taken from the guidance documents, while criteria 5 and 7 are based on our own recommendations" (Linnell et al. 2008).

"[T]he absolute minimum requirements that Member States must meet are:

- (1) Countries sharing one population, or segments of a population, contribute to ensuring between them that the population reaches and maintains FCS, and*
- (2) They allow for connectivity between neighbouring populations and segments within the same population, and*
- (3) Management activities do not create a sink that can influence the FCS of a population of any of its segments, and*
- (4) Populations should in general not be allowed to go below the level they had when the Directive came into force on their territory" (Linnell et al. 2008).*

Assessment of the current Alpine lynx population

The current population in the Alps is isolated and estimated at 130–180 animals (Kaczensky et al. 2013a, SCALP 2012; cf. Chapter 3.2) and, as such, far away from reaching FCS.

4.2 Potential distribution of the lynx in the Alps and hypothetical expansion of the population

The recolonisation of previously occupied habitat and the expansion of a recovering species or population are determined by factors such as the habitat and landscape features, land-tenure system, dispersal characteristics, resource availability and distribution, as well as human attitudes and activities (Zimmermann 2004).

Potential distribution

Three lynx habitat suitability models for the entire Alpine range have been published, by Zimmermann (2004), Signer (2010) and Becker (2013). Although the three models differ in type and

the data origin, the results are very similar, predicting approximately 90,000-100,000 km² (~50% of the area of the Alpine Convention) of suitable habitat.

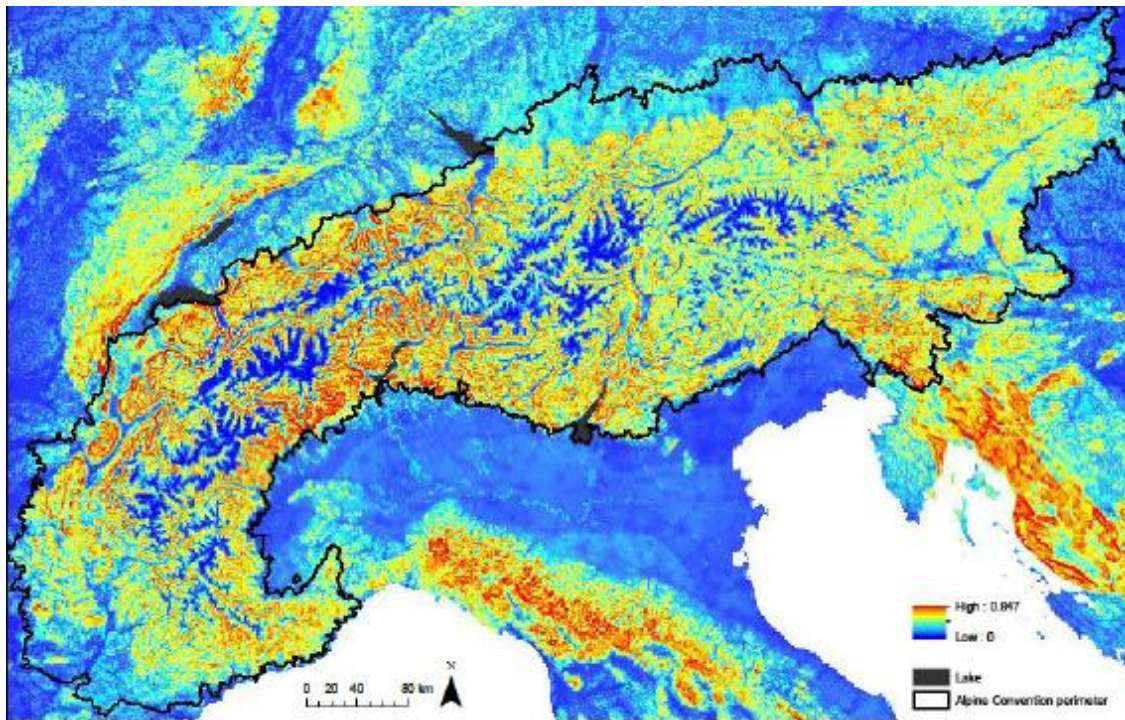


Fig. 5: Lynx habitat suitability map based on MaxEnt. Red = highly suitable habitat, blue = low suitable habitat (Becker 2013).

However, contrary to the models by Zimmermann (2004) and Becker (2013; Fig. 5), which revealed a slightly higher suitability of the western Alps, the model of Signer (2010) indicated a higher suitability for the eastern Alps. This is a consequence of differences between the input data sets. Zimmermann (2004) and Becker (2013) used among others radio-telemetry data from Switzerland, whereas Signer (2010) based the model on chance observations from Austria. As all habitat models perform better closer to the place of origin of the input data, Zimmermann's and Becker's model may be too conservative for the eastern Alps, while Signer's model may underestimate the suitable habitat in the western Alps.

Different (regional) models confirmed the lynx' preference for forested areas, followed by shrubs and herbaceous vegetation and an avoidance of intensive agricultural areas (Schadt 2002, Zimmermann 2004, Basille et al. 2008, Herdtfelder 2012). In the models, lynx avoided urban settlements and areas of high human activity (Zimmermann 2004). However, areas occupied by lynx are not necessarily free of human presence. "Distance to roads" was not negatively correlated to lynx presence in most of the models of Zimmermann (2004), indicating that, when lynx occur in good habitats, they can tolerate human presence. However, mainly highways seem to affect lynx occurrence (Zimmermann 2004, Basille et al. 2008, Rolland et al. 2011). Considering the bias towards the region of origin of data, the fact that Becker (2013) used the most comprehensive lynx data set (e.g. including GPS-telemetry fixes), and the fact that lynx can adapt to a certain degree to human presence, we conclude that at least 100,000 km² in the entire Alpine Arc consist of suitable habitat for lynx.

Fragmentation within the Alps (subpopulations)

Both, the habitat suitability map produced by Becker (2013) and Zimmermann (2004) predict a reasonably well connected area of suitable habitat throughout the Alpine range. However, when important barriers (major highways, rivers and high elevation areas), thought to be difficult but not impossible to cross by lynx, are included, the suitable habitat range is fragmented (Fig. 6). The model by Zimmermann (2004) predicts 37 patches ranging from 50 to 18,711 km² (patches smaller than 50 km² were removed from analysis because they are too small to host resident lynx) with 16 patches over 380 km². The model of Becker (2013) differed slightly; it detected 32 patches. Patch sizes ranged from 57–17,378 km² with 22 patches >400 km², supposed to be large enough to sustain a lynx subpopulation (Fig. 6; Becker 2013). Major barriers were defined subjectively based on experiences from radio-collared lynx in Switzerland, thus, patch division and size are only indicative and not definitive (Becker 2013).

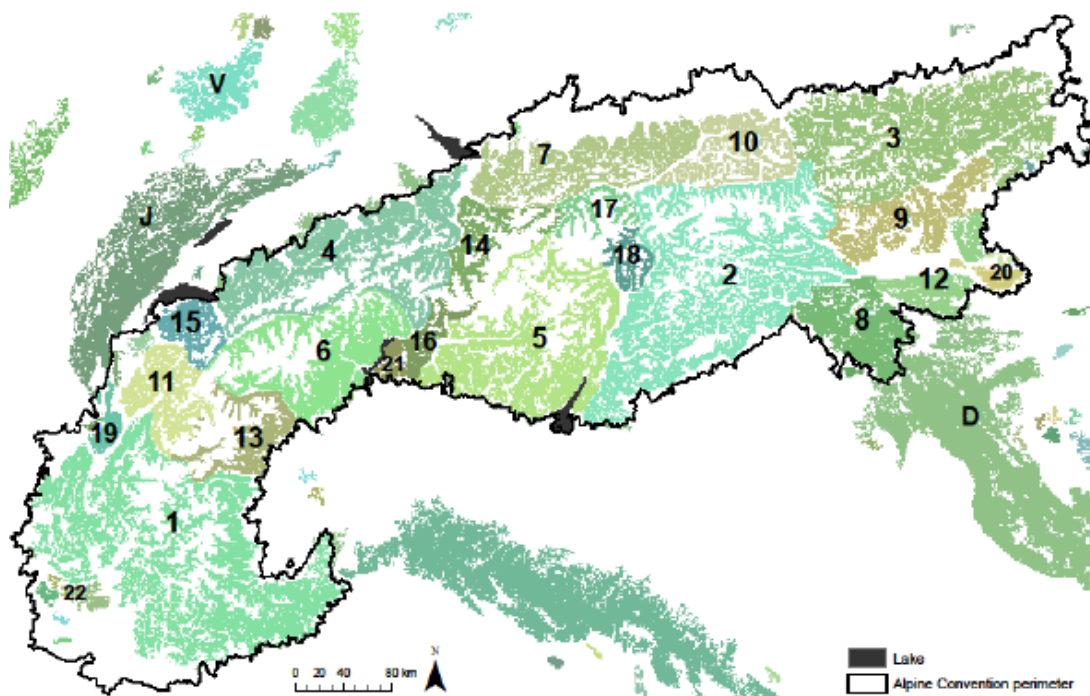


Fig. 6: Map of suitable lynx habitat patches divided by barriers as identified from experiences from radio-collared lynx in Switzerland. Each different coloured patch is assumed to represent lynx subpopulations. Patches greater than 400 km² are numbered in decreasing order of size. J = Jura, V = Vosges and D = Dinaric Mountains (Becker 2013).

Connectivity to neighbouring populations

The Alpine range is, in theory and according to the models, connected to the Dinaric Mountains, the Jura Mountains and to a lower extent the Bohemian-Bavarian lynx populations (Zimmermann 2004). The expansion of the Dinaric lynx population into the Slovenian Alps may have slowed down by urban areas, open habitats and the transport network (Potočnik et al. 2009). Two corridors connect the Alps and the Chartreuse, a 688 km² mountain which is relatively isolated from the rest of the French Alps (Zimmermann & Breitenmoser 2007), but close to the Jura Mountains. The French Alps are furthermore connected to the Jura Mountains through a corridor via the Salève Mountain (a

wooded mountain south of Geneva; Zimmermann 2004). Indeed, a subadult male lynx with a GPS collar used in 2013 exactly this corridor moving from the Swiss Jura Mountains to the French Alps.

Hypothetical expansion of the population

Of several reintroduction attempts in the 1970s, only the releases in the central-western Swiss Alps were successful (Breitenmoser and Breitenmoser-Würsten 2008). The lynx population expanded rather fast across the north-western Alps until about 1985 and then came to a halt. About 40 years after the first reintroductions, less than 20% of the total suitable habitat in the Alpine region is occupied and the spread of the lynx population appears to have stagnated in spite of the high amount of suitable habitat still available (Molinari-Jobin et al. 2010a). Only following translocations and releases to north-eastern Switzerland and the Austrian Kalkalpen, the distribution of lynx expanded slightly (Zimmermann 2004, Becker 2013).

Dispersing lynx can – just like wandering wolves – overcome almost any human-made barrier and can also cross high alpine passes. However, the land tenure and social system of the two species and consequently the spread of a population differ considerably. While wolves were observed to build packs and form new population nuclei far away from the permanently occupied areas in the Alps (REF TO WOLF REPORT), lynx were never observed to do this (in the Alps). Lynx are conservative colonisers, as they need to settle in contact to neighbouring resident lynx in order to breed (Breitenmoser and Breitenmoser-Würsten 2008). Therefore, a lynx population does not easily spread across barriers that are no major obstacle to the movement of an individual dispersing lynx (see below).

The lynx populations in the Alpine range are relatively isolated from each other and only very few migration events between populations occur (Becker 2013). The social structure of the lynx, their need for contact with conspecifics to establish a home range, their dispersal behaviour and the supposed low migration rate between subpopulations, based on cost-distance analysis and experience, is thought to be too low to allow the foundation of a new population in a not yet occupied area (Zimmermann 2003, Zimmermann 2004, Becker 2013). Thus, the natural recolonisation of not yet occupied areas by lynx in a fragmented landscape such as the Alps is impeded (Zimmermann 2004, Zimmermann et al. 2007). For example, due to the low probability that even a single lynx (e.g. from the north-eastern Swiss Alps) would reach the Bavarian Alps, a natural recolonisation of this area and the establishment of a viable population was considered relatively unlikely (Molinari-Jobin et al. 2010b). Based on the empirically observed expansion rate between 1995 and 2007, Molinari-Jobin et al. (2010b) estimated that in 2017, only 28,000 km² of the Alps will be occupied by lynx; still less than 20% of the Alpine Arc.

4.3 Assessment of a future Alpine lynx population

We base the assessment of a future Alpine lynx population on the situation where the whole of the Alpine Arc is settled, i.e. the Favourable Reference Range is occupied according to Criterion 6 of the operational definition of FCS by Linnell et al. (2008; Chapter 4.1). Obviously, the crucial points in the operational definition for the future lynx population in the Alps are Criteria 5 (number of mature individuals) and 7 (connectivity within and between populations).

Potential abundance

The Alpine-wide habitat models calculated an area of suitable habitat of approximately 100,000 km². The camera trap monitoring in Switzerland calculated densities of 1.36–3.61 independent individuals per 100 km² of suitable habitat¹⁸. Based on these densities, the Alps could host about 1,350–3,600 lynx. However, these calculations were done for “independent individuals”, not for mature individuals. “Independent individuals” include subadult lynx (in their second year of live, likely on dispersal). The number of subadult animals compared to the total number of lynx >2 years of age depends on the status of the population and can fluctuate. In one study (Breitenmoser-Würsten et al. 2001), the share of subadults compared to the resident mature individuals was estimated to be 25% in the north-western Swiss Alps. In other words, 1,000 mature individuals equal approximately 1,300 independent individuals. By coincidence, this is the lower range of potential abundance estimated from habitat models and empiric densities.

Connectivity within the Alps

Zimmermann et al. (2007) found that subadult lynx were rarely crossing major barriers such as highways. Molinari-Jobin et al. (2010b) predicted that natural dispersal will not suffice for the recolonisation of the Bavarian Alps. The models of Becker (2013) and Zimmermann (2004) showed a separation of the Alpine population into 32 and 37 different patches, respectively. All these findings do not answer the question about connectivity within the Alps in a definitive manner, but they give a hint that connectivity may be a problem for lynx in the Alps, at least during the phase of recolonisation. However, although the natural and anthropogenic barriers are hindering the expansion of the extant populations, they will most likely not be a problem for the maintenance of the genetic viability of the “subpopulations” if once the whole of the Alpine Arc is occupied. There are enough empiric observations of dispersing lynx from radio-telemetry or camera trapping to conclude that at least one animal will cross the barriers between subpopulations per generation.

Connectivity to neighbouring populations

The Alpine range is, in theory and according to the models, connected to the Dinaric Mountains, the Jura Mountains and to a lower extent the Bohemian-Bavarian lynx populations (Zimmermann 2004). Whether this connection would exceed the benchmark set in the Guidelines of one genetically effective migrant per generation has not been studied. So far, only one lynx was documented to have dispersed from the Alps to the Jura Mountains across the Swiss Plateau and reproduce successfully. Two were known to have dispersed in the other direction, but both did not integrate into the population. This anecdotic observation suggests that the dispersal of lynx leads only to a very low amount of exchange between populations. The Chartreuse, a region in the French Alps on the east side of the Rhone river, was obviously settled from the Jura Mountains (Zimmermann & Breitenmoser 2007). But the Chartreuse itself seems so far being separated from the Alpine population. However, all three populations, but especially the one in the north-western Alps and the Dinaric population suffer from inbreeding and might (e.g. in Slovenia and Croatia) have presently a reduced recruitment.

¹⁸ In one case, a density of 0.92 independent lynx per 100 km² of suitable habitat has been revealed. However, this value comes from an obvious sink population and has therefore not been considered for the present calculation.

Conclusions

When once the whole of the Alpine Arc is (re-)colonised by the lynx, it would probably have a sufficient genetic exchange with neighbouring populations (considering those have an adequate conservation status, too). However, the migration rate would probably be so low that it would be demographically insignificant. Therefore, current knowledge dictates that the FCS for the Alpine lynx is set for an isolated population, i.e. at 1,000 mature individuals (NT). Habitat models predict that a healthy and evenly distributed Alpine lynx population has a good potential to reach FCS at this level, even at low to moderate lynx densities. Indeed, if the prerequisites allow lynx to occur at high densities across the Alps, the abundance at carrying capacity may be almost three times as high as the minimum requirements for FCS.

4.4. Challenges for the recovery and conservation of the Alpine lynx population

4.4.1. Ecological/biological challenges

Connectivity and habitat fragmentation

While enough suitable habitat and prey in the form of wild ungulates are available to the lynx, one of the major threats lies in the fragmentation of said habitat. Some of the fragmentation stems from the natural Alpine landscape (e.g. high mountain ridges), but much of it originates from anthropogenic structures, especially in the lower regions. As a result, there is a lack of connectivity within the Alps as well as to other populations adjacent to the Alps. Although individual lynx have the ability to cross most types of barriers, its dispersal ecology is such that the population as a whole cannot overcome them. Consequently, there is a lack of population expansion, which contributed to a high amount of inbreeding in the population.

A natural population expansion over the whole of the Alpine Arc is highly improbable, even in the long term (Chapter 4.2). Therefore, the anthropogenic support is required and needs to be organised. A way to aid the expansion of the lynx population are translocations and further small-scale reintroduction projects as the ones carried out in north-eastern Switzerland or in the Kalkalpen National Park in Austria. These were indeed the latest significant population developments in the Alps. Rüdissler (2002) proposed such an approach also for the western Austrian Alps. Reintroduction projects in southern Vorarlberg, eastern Tyrol and western Salzburg would allow establishing further subpopulations and eventually connect the now isolated lynx occurrences in the Alps (Rüdissler 2002).

Inbreeding

The north-western Alps population is by far the largest subpopulation in the Alps. However, as a consequence of the very small number of founder individuals some 40 years ago and the slow growth of the population, it is now strongly inbred. Evidence of genetic drift and reduced heterozygosity are clearly visible in the lynx population in the north-western Alps (Breitenmoser-Würsten & Obexer-Ruff 2003). Criterion D in the IUCN Red List assessment, simply considering “number of mature individuals”, does not recognise issues resulting from inbreeding, which is a major threat to the current lynx populations in and adjacent to the Alps. To present a more realistic picture, the number of individuals (both sexes) contributing genetic variation to the population size ($N_{e\text{ genetic}}$) should be considered to estimate the size of the population instead of just mature individuals (MI). Inbreeding can considerably reduce $N_{e\text{ genetic}}$ compared to MI. For instance, the

inbred lynx populations in the Dinaric range and the north-western Alps have a strongly reduced N_e if inbreeding is considered. During the International Workshop "Genetic status and conservation management of reintroduced and small autochthonous Eurasian lynx *Lynx lynx* populations in Europe" held in November 2011 in Saanen, Switzerland, the experts estimated $N_{e\text{ genetic}}$ for the Dinaric population to be about 11 and for the NW Alps about 18 (in a population with a MI of about 54 lynx). In the latter case, N_e would be only 0.33 of the number of independent lynx as estimated from camera trapping (Ch. Breitenmoser-Würsten, pers. comm.). In both reintroduced populations, the inbreeding factor F_{it} is close to 0.25, indicating that all members of the population are as closely related to each other as siblings. Consequently, regardless of the total size of the present population, the genetic remedy of the reintroduced population is a prerequisite for the colonisation of the whole of the Alps, or in other words, the low $N_{e\text{ genetic}}$ and the limited distribution is a more serious obstacle to reaching FCS in the future than the actual number of MI in the Alps. So far, the inbreeding in the North-western Alps has not led to measurable demographic problems (e.g. reduced litter size or juvenile survival; Ch. Breitenmoser-Würsten, pers. Comm.). However, in the Dinaric population, where the inbreeding coefficient has reached $F = 0.3$, a strong population drop combined with a decrease in natality was observed, suggesting an inbreeding depression (R. Černe, pers. comm.).

For a colonisation of the entire Alpine range by lynx and to allow genetic exchange, it is necessary to close the gaps between the nucleus in the eastern Alps (Slovenia and Austria) and the one in the north-western Alps (Kaczensky 1998, Molinari-Jobin et al. 2003). For the long-term survival of the lynx in the Alpine range and the conservation of the species, it is crucial to connect the small and genetically isolated lynx subpopulations in the Alps so that they form part of larger metapopulations allowing the exchange of individuals between neighbouring subpopulations and thus to guarantee genetic viability (Rüdisser 2002, Zimmermann 2004, Becker 2013). Kramer-Schadt et al. (2011) analysed the effect of "stepping stones" (local lynx population nuclei) and found that they could significantly enhance the colonisation. They however postulated that stepping stones would need to be big enough to produce new dispersers; otherwise they could even negatively impact the colonisation success by binding animals. This is especially noticeable in areas with low to medium dispersal habitats and in cases of high mortality among dispersers. Reintroductions and translocations to new parts of the Alps should additionally be done in a way to remedy the inbreeding of the remnant populations, that is, when exchanging animals, the genetic constellation of the respective populations must be considered, and new individuals from the original Carpathian source population must be added.

4.4.2. Management challenges

Multitude of administrative units

While the measures may change over time with the development of the population, they should still follow the same goals and respect the same management principles in different administrative units to allow a consistent management of the entire population. The "administrative fragmentation" is a two-level challenge in the Alps. On the one hand, the suitable lynx habitat in the Alpine Arc is distributed over seven countries; on the other hand, in some of these countries (Italy, Switzerland, Austria and Germany), hunting and wildlife management is a competence of the federal states (provinces). Although all large carnivores are legally protected by national, hence higher-ranking laws, the implementation of conservation or management measures generally leads to discussions

over competences, and the implementation of international agreements is hence a challenge at national level.

Guiding strategic document

Unfortunately, no guiding strategic document exists, which would define the aforementioned common goals and management principles for the lynx population in the Alps. There is the Pan-Alpine Conservation Strategy for the lynx (Molinari-Jobin et al. 2003), which was formally endorsed by the Standing Committee of the Bern Convention. However, it was never endorsed or considered at national level. Switzerland has a national Action Plan (BUWAL 2004a) and Slovenia is currently in the final stage of developing a national strategy for conservation and sustainable management (M. Jonožovič, pers. comm.). Germany has a framework document by the Federal Agency for Nature Conservation on how to deal with management issues concerning lynx, wolf and bear (BfN 2010) some parts of which have been published elsewhere (Kaczensky et al. 2009, Reinhardt et al. 2012). The results from the RowAlps process and possible follow-ups in the WISO Platform and the Alpine Convention may contribute towards the abatement of this shortcoming, insofar as they may establish a basis for an overarching guiding strategy or national documents. However, the RowAlps itself cannot replace a Regional Strategy/National Management Plan.

Wildlife management systems

The presence of lynx also poses a challenge to the established wildlife management and hunting systems. Lynx have an impact on the populations of their prey species. The nature and magnitude of such impacts in terms of changes in abundance and behaviour is hard to predict exactly because it depends on several important co-variables. However, it is undisputable that lynx and hunters are using the same resource, wild ungulates, and that their “harvest rates” often show the same trends (i.e. an increase in the game population results in a higher hunting quota, but also allows a higher predator density, which in turn results in a higher predation on the prey population). Therefore, the lynx needs to be included in management decisions (e.g. calculation of hunting quota). This requires an adaptive approach with changes over the years depending on the gained experience about the impact of lynx on the huntable species. Hence, the monitoring of the wild ungulate populations may require intensification so that the possible necessity for adaption of the management can be detected in time. Whatever the changes in the established wildlife management system will be, at least a good communication towards the stakeholders is crucial, preferably even an involvement in the decision-making process.

Conclusions

Tackling the socio-economic and management challenges will require both, top-down and bottom-up approaches, and will heavily rely on good communication. For example, necessary changes to long-lasting, possibly even traditional, wildlife management or livestock husbandry systems might be perceived negatively by those affected. The involvement of stakeholders in all processes should aid in preventing, or at least limiting, such a negative effect. Treves & Bruskotter (2014) emphasised the importance of always pointing out actual benefits of carnivore presence. If only the avoidance and reduction of problems and risks are addressed, social acceptance might decrease, possibly by increasing the perception of problems and risks (Treves & Bruskotter 2014).

However, even without any anthropogenic threats, the Alpine lynx population would still be in peril in the long-term due to genetic problems resulting from inbreeding. The cure for this situation calls for the insertion of new, genetically appropriate individuals. The natural expansion of the population

is hampered by obstacles emerging from habitat fragmentation. The creation of new population nuclei through translocation projects is probably necessary. Again, good communication is required in preparation of such projects. Affected stakeholders, e.g. hunters, are usually more tolerant towards the appearance of a species in an area, if the recolonization happens naturally (WISO 2010).

On the positive side, financial requirements for managing conflicts with livestock owners are relatively low compared to the wolf, and especially compared to other elements at national level. Nevertheless, even a comparatively low financial provision demands a commitment from society and political bodies.

4.4.3. Most important threats and/or shortcomings

The threat assessments published since the year 2000 (Breitenmoser et al. 2000, Molinari-Jobin et al. 2003, von Arx et al. 2004, Council of Europe 2012, Kaczensky et al. 2013a, Boitani et al. 2015; compiled in Breitenmoser et al. 2015) largely agree on the main threats to the lynx population in the Alps and in Europe in general. They consist mainly of persecution, accidental mortality (vehicle collisions), habitat deterioration due to infrastructure development, and low acceptance due to conflicts with hunters, combined with the intrinsic limited dispersal capability of the species. The more recent assessments also list inbreeding as a threat for the present and/or future lynx population. Additionally, the most recent assessment in Boitani et al. (2015), lists poor management structures as a threat to the present lynx population in Europe. The same was already the case in Kaczensky et al. (2013a), the analysis of which was performed by sending questionnaires to the members of the Large Carnivore Initiative for Europe (LCIE) and further experts, for the present lynx population in Europe. However, poor management structures were not among the top 4 threats for the future population. This is due to the increased importance of other threats, not due to a decrease in importance of this threat.

At the workshop from 12–13 March 2015 of the RowAlps working group³, the major threats to the lynx and/or shortcomings were identified based on a presentation of the reports mentioned above. Illegal killing was evaluated to be the main threat, followed by inbreeding/genetic problems, and habitat fragmentation. Poor management in general was rated as one of the main shortcomings, but two more specific parts of the management were listed as well. Issues related to wildlife management systems and/or hunting systems were rated among the major shortcomings (e.g. the regional overharvest of prey), as well as the lack of strategic documents, management or conservation plans with national or regional goals. Accidental mortality and the lack of regionally specific knowledge were also nominated.

Major threats to the Alpine lynx population and shortcomings:

1. Illegal killing
2. Inbreeding/Genetics
3. Habitat fragmentation
4. Management issues
 - a. Wildlife management systems/hunting system
 - b. Lack of strategic documents, management or conservation plans
 - c. Poor management in general
5. Accidental mortality
6. Lack of regionally specific knowledge

5 Practical goal

The overall practical goal is to achieve a favourable conservation status (FCS) of lynx in the Alps of at least 1000 mature individuals/1300 independent individuals widely distributed across the Alps. This implies especially strengthening transboundary cooperation, dialogue with local people and interest groups and active conservation measures.

To reach FCS, a more or less even distribution of the 1000 mature lynx at low to moderate density is required across the Alpine countries according to suitable habitat.

Table 5. Minimum number of mature and independent individuals, respectively, needed per country to reach FCS. Allocation to the countries was made in proportion to available suitable habitat¹⁹.

Country	Minimal number of mature/independent individuals to reach FCS of at least 1000 mature individuals
France	184 mature / 245 independent ind.
Italy	308 / 410
Switzerland	138 / 184
Liechtenstein	1 / 2
Austria	290 / 387
Slovenia	49 / 65
Germany	33 / 44

The main threats to the present and future lynx population in the Alps are illegal killing, inbreeding and habitat fragmentation. Moreover, low acceptance, poor management structures and accidental mortality have to be dealt with, in order to reach FCS for the lynx in the following decades.

For this purpose, the most important management issues are to merge the eastern and western subpopulations, to manage these populations genetically, to secure and construct new connection corridors, to prevent illegal action, to foster dialogue among authorities, with wildlife managers, hunters and foresters, to integrate local people in monitoring systems, and finally to secure damage prevention and compensation systems.

6 Management options and implications

Lynx conservation in the Alps needs to be actively managed, namely the genetic remedy and the merging of the subpopulations requires interventions. As most of the threats and challenges are related (e.g. the high anthropogenic mortality is responsible for the slow growth of the population, which in turn is speeding up the genetic drift), conservation measures must be considered jointly where appropriate.

¹⁹ The minimum number of lynx per country were calculated from the proportion of suitable habitat per country according to Becker (unpublished data from the model of Becker 2013). As the calculated numbers of lynx per country were a minimum, all numbers were rounded up, resulting in a sum that is slightly higher than 1000. These numbers correspond to a density of 1.0 mature individuals (lynx > 2 years of age)/1.3 independent individuals (lynx > 1 year of age) per 100 km² favourable habitat.

6.1 Merge eastern and western subpopulations

Currently, the eastern and western lynx subpopulations in the Alps are separated and isolated and it is most improbable that the connection between the existing subpopulations will be established in a natural way. However, such a connection is vital for the survival of the Alpine lynx population, simply by combining the two subpopulations into a larger meta-population with an improved genetic pool and reduced extinction probability.

The intrinsic dispersal capability of the Eurasian lynx in the fragmented Alpine landscape is rather limited. Long-range dispersal is very rare and between the existing subpopulations highly unlikely. Individual lynx are capable of crossing most kinds of landscape barriers (possibly with the exception of large water bodies and high mountain ridges). However, for example, three out of four lynx were not able to cross a highway and turned back after spending a few days in its vicinity, leading to circular dispersal. The few individuals which manage to disperse across major barriers, are then isolated on the other side and subsequently not able to form a new population nucleus. Therefore, actively creating “stepping stones” in form of a small number of lynx, possibly taking advantage of known isolated individuals, would help to spread and eventually to merge the populations.

Option 6.1.1: Founding of a new subpopulation

A main contributor to the recent population expansion in the Alps was a reintroduction project in north-eastern Switzerland between 2001 and 2008. It was created by translocating a total of 7 females and 5 males. A decade after the translocations, the subpopulation now consists of 16 independent individuals (16-22, 95% CI) and at least 8 juveniles, and the density has significantly increased over the last six years.

The creation of another subpopulation in the central-eastern Alps would considerably increase the chance of connecting the two remnant subpopulations. A full reintroduction project (with the goal to create a self-sustaining population) is a big endeavour requiring the necessary capacity and funding. Furthermore, it requires careful preparation and planning, regarding the source of suitable animals and the area of release. The reintroduction should be carried out according to the “IUCN Guidelines for Reintroductions and Other Conservation Translocations” (IUCN/SSC 2013). The endorsement of official governmental bodies and the involvement of relevant stakeholders are key preconditions.

Option 6.1.2: Create new population nuclei between the eastern and western subpopulations by colonising “stepping stones”

In ecology, the term “stepping stones” is used for rather small habitat patches lying between larger habitat areas. While the larger habitat areas are not within reach of each other for a dispersing animal, the stepping stones lie within dispersal distance of the larger habitat areas and of each other. Of course, the design of the stepping stones must adhere to certain principles to be effective (see Kramer-Schadt et al. 2011). However, in the case of the Alpine lynx population, we refer to “stepping stones” as “small population nuclei” founded in suitable habitat anywhere between the two remnant subpopulations.

The creation of new “stepping stones” population nuclei would create a connection between the subpopulations. Individuals will still not be able to disperse all the way to the other subpopulation, but they may reproduce within the “stepping stone”, creating a genetic exchange and producing offspring, which may disperse again to further “stepping stones”. *Ergo*, “stepping stones” do not need to be large populations, but strong enough to create new dispersers.

As the main ridges in the Alps pose a very strong barrier to the expansion of a lynx population, two chains of “stepping stones” are suggested, one in the north, the other in the south. “Stepping stones” would be smaller than reintroduced subpopulations (Option 6.1.1). Hence, the effort per “stepping stone” is considerably smaller. Still, the same care in the execution is required and the principles of the “IUCN Guidelines for Reintroductions and Other Conservation Translocations” (IUCN/SSC 2013) should be considered. The endorsement of official governmental bodies and the involvement of relevant stakeholders are key preconditions.

Option 6.1.3: Add lynx to areas with isolated individuals

The basic reasoning and goal is the same as for Option 6.1.2. The main difference between this option and Option 6.1.2 lies in the selection of an area of release. While the area in Option 6.1.2 is selected by experts and wildlife managers, here it is specified by the lynx occurrence. Single, isolated individuals should be reinforced, as has happened e.g. in the Kalkalpen National Park, thus creating new population nuclei “stepping stones”. Apart from the selection of the area, the preparation and planning requires the same care as for Option 6.1.2. As the first individual recolonised the area naturally, the acceptance of the local population might be slightly more positive than for the creation of a completely new nucleus in a formerly uncolonised area.

The reinforcement of the isolated individuals should be carried out according to the “IUCN Guidelines for Reintroductions and Other Conservation Translocations” (IUCN/SSC 2013).

All three options for an active merging of the remnant Alpine lynx populations require suitable source animals (see Note under 6.2. Genetic management).

The north-western and south-eastern Alpine lynx subpopulations (incl. the adjacent Dinaric population) suffer from strong inbreeding, which should be addressed for the sake of the Alpine lynx population. The inbreeding is a consequence of a too small founder group and genetic drift, and considerably threatens their survival. Genetic remedy of the north-western Alpine and the Dinaric (south-eastern Alps) populations is urgent.

A requirement for any genetic management of a (sub-)population is an adequate genetic and demographic monitoring, also of the potential source populations. Such a monitoring has been established for the existing (sub-)populations in the Alps and Dinaric range.

6.2 Active genetic management

The north-western and south-eastern Alpine lynx subpopulations (incl. the adjacent Dinaric population) suffer from strong inbreeding, which should be addressed for the sake of the Alpine lynx population. The inbreeding is a consequence of a too small founder group and genetic drift, and considerably threatens their survival. Genetic remedy of the north-western Alpine and the Dinaric (south-eastern Alps) populations is urgent.

A requirement for any genetic management of a (sub-)population is an adequate genetic and demographic monitoring, also of the potential source populations. Such a monitoring has been established for the existing (sub-)populations in the Alps and Dinaric range.

Option 6.2.1: Enrich the genetic pool

There is only one option to address this issue: the impoverished genetic pools of the existing subpopulations must be enriched again, i.e. alleles which have become rare or even non-existent in a population, need to be reintroduced via suitable new individuals. There are several options

possible/available for the execution of this basic concept (see below), and suitable source animals need to be defined on a case by case basis. Generally, according to the recommendations of participants of a workshop on the genetic status of lynx, we consider as suitable an individual of the same subspecies *L. l. carpathicus* with a good genetic and health record and in reproducible age, preferably from the wild.

Option 6.2.1a: Reinforce the existing subpopulations

The genetic situation may be remedied by simply releasing new individuals within the remnant subpopulations. Release areas should be carefully chosen according to information from the *in situ* monitoring in order to minimise potential conflicts of the new animals with resident lynx. If such information is not available, individuals may be released at the edge of the known distribution area – if suitable habitat is available there. Adding lynx to a local population that may be considered “too large” by local people and land users could however enhance conflicts, and information and communication is therefore of outstanding importance.

Option 6.2.1b: Replace known anthropogenic mortality

In contrast to Option 6.2.1a, Option 6.2.1b does not change the population size as it would only replace any known anthropogenic mortality with genetically suitable individuals. The social acceptance for this option may hence be higher than for Option 6.2.1a. As the basic idea is to compensate for human-caused losses (e.g. traffic mortalities), the release area should be chosen relatively close to the site where the animal died.

Option 6.2.1c: Replace known illegal mortality

In contrast to Option 6.2.1b, Option 6.2.1c would only replace any known illegal mortality. The general social acceptance for this option may be higher still than for Option 6.2.1b. However, this may create a management link between the conservation measure of the genetic remedy, and the controversies surrounding the social acceptance and illegal killings, which may hamper the conservation measure. Furthermore, much of the illegal killings are most likely never discovered, and hence the rate of new genes brought into the population may be very low.

Option 6.2.1d: Remove and replace “genetically problematic” individuals

An adequate genetic monitoring may be able to identify individuals carrying maleficent alleles or areas with locally high degree of inbreeding. For example, in the north-western Alps subpopulation, the genetic lineage responsible for the observed heart problems (Wahli 2015) is known. In such cases, it is an option to actively remove the carriers of these alleles from the population and to replace them with suitable new individuals. Genetically, this option may be the most desirable as it removes the problematic genes from the population.

Note to options under Chapter 6.1 and 6.2:

The lynx population in the north-western Alps and the Dinaric population (including their Alpine part) cannot serve as sources for further translocations, as they are strongly inbred. Source populations can be the Carpathian population (Slovakia or Romania) and any genetically suited reintroduced population.

To support the preparation of the above options, i.e. to ensure that enough animals can be provided, the establishment of adequate infrastructure and capacity in the source populations/countries should be secured, e.g. in Slovakia or Romania. Assistance may be in the form of, e.g. training courses for “capture teams”, but also knowledge transfer and information exchange regarding the screening and preparation of suitable animals (genetic monitoring, quarantine, etc.).

6.3 Secure and construct new connection corridors

One of the requirements for reaching FCS is a functioning connectivity within the population, while the connection to neighbouring populations can facilitate achieving FCS. Lynx seem to be less able to cross barriers than e.g. wolves, and models have shown that a future Alpine population would possibly be divided into separate subpopulations due to barriers. However, individual lynx are capable of crossing most kinds of landscape barriers (possibly with the exception of large water bodies and high mountain ridges) incl. (fenced) highways. The point is that the spread of the population is still not granted across a barrier even if individuals are able to cross the obstacle. Therefore, corridors allowing a constant flow of individuals should be managed to ensure the connectivity within the population and possibly enhance the connectivity to neighbouring ones.

Option 6.3.1: Improve connectivity between existing subpopulations within the Alps

The connectivity between existing subpopulations within the Alps should be enhanced. Even if the current level of connectivity in the existing subpopulations is probably sufficient, for when the Alpine meta-population has once established. However, it is not enough to allow the natural population expansion. Enabling the natural expansion requires the improvement of the connectivity by removing barriers where possible and installing habitat corridors.

Connectivity is generally understood as a net of large quiet and/or protected areas for both ungulates and large carnivores and connecting habitat corridors between them. Such a green infrastructure can be maintained and improved with the help of spatial planning especially by realising projects in regional, national and transboundary contexts that are based on participatory processes and supported by local politicians and communities. Such projects might restore fragmented landscapes where possible (e.g. by green bridges, habitat corridors etc.) or reduce disturbance by tourists (by e.g. raising awareness or guiding tourists with hiking and biking trails using signs etc.). Finally, respective goals on connectivity shall be integrated in national policies and strategies (e.g. national strategies for biodiversity conservation) and concrete measures shall be synchronised within the Alpine countries.

Option 6.3.2: Create or maintain connectivity between potential subpopulations

Reaching the long-term goal of one large Alpine population requires ensuring the connectivity within the future Alpine population. This could be done in advance, before lynx actually recolonise the areas concerned. Crucial points can be recognised from models (cf Fig. 6 in Chapter 4.2) and/or identified based on experience. The scale of the project would differ on a case by case basis and may reach dimensions of ensuring connectivity across a landscape feature such as the Rhine valley in eastern Switzerland. A special focus should lie on the connection of the existing subpopulations and areas of possible reintroductions.

Option 6.3.3: Maintain or improve connectivity of (potential) Alpine subpopulations with populations adjacent to the Alps

Achieving FCS can be facilitated by enlarging the meta-population; in the case of the Alps by establishing a sufficient connection with neighbouring populations (e.g. Jura, Dinaric). The scale of the project would differ on a case by case basis. In the south-east, where the Alpine population is separated from the Dinaric population by a highway, the creation of green bridges may suffice. Elsewhere, measures on a landscape scale would be required, e.g. to achieve a connection with the Bohemian-Bavarian-Austrian population.

Option 6.3.4: The Alpine Convention Contracting Parties pursue the creation of an ecological network at national and cross border level

To achieve this goal (Protocol “Conservation of nature and the countryside”; art. 12) the platform ecological network supports the establishment of an alpine ecological network, a coherent network of interlinked natural spaces in order to guarantee the sustainable protection of the Alpine biodiversity (by promoting transboundary cooperation, practical workshops, nomination of pilot regions etc.)

6.4 Prevent and persecute illegal action through law enforcement

Illegal killing is one of the main threats to lynx in Europe and can have a severe effect on the local population. However, environmental crimes are usually not a priority in law enforcement and only special cases are even noted publicly (e.g. Stadt Bern 2000²⁰, Bayerischer Rundfunk 2015²¹, ORF 2015²²). The following options intend to increase the awareness of the problem and of its severeness, and to improve its persecution/abatement.

Option 6.4.1: Establish or strengthen corps of independent state employed rangers and game wardens

In some Alpine countries (e.g. France, Slovenia) or in parts of these countries (e.g. Switzerland, Italy), state wildlife rangers with official status are overseeing the implementation of hunting and wildlife protection laws. Such institutions are generally better positioned to investigate or persecute wildlife crime than privately employed game wardens. An official wildlife crime corps should be established.

Option 6.4.2: Awareness raising within police, state attorneys and judges regarding illegal mortality of protected species

The law enforcement corps may not be aware of the severeness of crimes against strictly protected species, e.g. large carnivores or are generally not familiar with nature conservation regulations. Awareness of the issue should to be raised for all levels of legal intervention, from the game warden to the judge by e.g. inviting enforcement authorities to round tables (see option 6.5.1) and offering training courses.

Option 6.4.3: Secure and guarantee professional investigation methods

Investigations on illegal wildlife killing require specific professional skills. In the past, CITES and Interpol have collaborated in the organisation of courses, specific to the issue of wildlife crime. Contact with these two organisations should be made regarding the education of investigators and prosecutors.

Option 6.4.4: Enable and encourage interest groups to address illegal actions

Law enforcement – especially with regard to wildlife crime – is generally only successful if it has a broad societal acceptance and is supported by specific interest groups, such as the hunters. Stakeholder groups should be informed about the severeness of the problem of illegal killing of lynx and should be invited to rigorously employ the existing legal framework and address the issue in the broad public.

²⁰ http://www.bern.ch/mediencenter/aktuell_pol_feu/2000-02-926

²¹ <http://www.br.de/nachrichten/oberpfalz/inhalt/tote-luchse-bayerischer-wald-100.html>

²² <http://ooe.orf.at/news/stories/2715954/>

6.5 Foster dialogue among authorities, with wildlife managers, hunters and foresters by establishing information and consultation mechanisms regarding the lynx

Law enforcement, but also the implementation of conservation and management options listed above, require the support by the public and especially by interest groups concerned (e.g. land owners and land users). More than forty years of experience since the start of the lynx reintroductions in the Alps have revealed that a strong legal framework alone does not guarantee the survival of the populations. Participatory processes are required. Participation, by definition, means more than just the provision of information. It is the aim to turn persons affected into persons involved, which means that compromises and common decisions must be possible. This means also that, for some issues, participatory processes are not possible. Political and legal preconditions are required which enable the possibility of reaching such compromises and common decisions. Otherwise, the process will cause frustration. However, even if a participatory process is not possible in the decision-making for a certain issue, it may e.g. still be possible for the when, where and how of the implementation. For a review of key elements of stakeholder engagement and public participation we refer to Linnell (2013). In general, the inclusion of all affected actors in decision making but specifically in the process of developing management plans is absolutely essential.

Option 6.5.1: Establish round tables and workshops to encourage dialogue among authorities and interest groups

There are conflicting goals between and within the fields of agriculture, forestry, hunting and nature protection. While the legitimacy of each of these conflicting goals cannot be discussed, the extent of the disagreement should be identified. A possible solution is a prioritisation of the goals. An earnest dialogue addressing all critical and controversial points between the different interest groups should be started with the aim to develop common ground and find compromises with regard to lynx management and conservation. This dialogue should be facilitated by an independent and broadly accepted institution or mandated key person.

Option 6.5.1a: Establish different forms of participation in pilot regions and evaluate outcome in terms of best practice projects

There are different forms of participation processes. These vary in terms of organisation of the group, e.g. who moderates the group, the requirements of work investment for the participants of the group, the influence that the results of the group can have (participation of GO representatives from different administrative levels and agencies). For example, the analysis of one participatory process can be found in Boutros & Baumgartner (2004). The effectiveness of such variations should be tested in order to establish best practice guidelines.

Option 6.5.1b: Based on consultations with interest groups, authorities develop and implement guidelines on how to integrate lynx presence into ungulate and forest management.

The experience with previous round tables and involvement of interest groups reveal that for the lynx the main conflict zone lies within the ungulate hunting management. Wildlife management as it has developed in the Alpine countries in the 20th century mainly tries to balance between hunting and forest harvest, hence to maintain relatively high ungulate densities while mitigating browsing damage. The impact of an efficient predator such as the lynx on the ungulate populations is a “new” and maybe considerable factor in this system and should now be taken into account in order to avoid conflicts of goals. In the field of hunting, potential ways to adapt ungulate (game) management to the presence of lynx should be discussed, for example with

regard to harvest quotas and feeding practices (feeding stations, baiting, fruit trees, waste management in villages) as well as hunting practices and regulations. Furthermore, adaptation of forest management practices to reflect the carrying capacity for ungulates, and compensation schemes to address the impacts of browsing damage by ungulates due to verifiable impacts of lynx should be considered. This would require a dialogue between wildlife managers, hunters, foresters, and conservationists with the aim to adapt given wildlife management practices, especially ungulate and forest management. In addition, measures to improve ongoing internal communication and exchange between hunters regarding lynx should be integrated into lynx management plans.

Option 6.5.1c: Create suitable units for lynx, ungulate and forest management within the national borders and cross-border

As lynx need a lot of space, its management entails a different spatial scale than traditional ungulate or hunting management. Inadequate management units (e.g. for monitoring or assessment of status) often result in wrong conclusions. The Alpine countries should therefore identify and establish adequate management units for the monitoring and conservation of lynx. Such units should consider habitat and subpopulation models, but can also be based on existing units (e.g. hunting units or national subunits).

Management units could also incorporate areas that are especially important for the return of lynx (cross-border regions, regions that adjoin core areas of lynx etc.) and areas, where the implementation of livestock protection might be more complex and/or land use practices require fundamental changes.

Option 6.5.2: Enable and foster fact-based in-group communication

Norms that guide, for example, hunting practices are very important and can be influenced by in-group communication. Therefore such in-group communication should be encouraged and also supported by providing relevant facts. The information used should come from a source which is generally accepted to be objective. A structure for the communication of such objective information should be established, too. It is even more effective, if in-group actors were involved in the gathering of the information.

Option 6.5.3: Undertake regular systematic public surveys to evaluate and refine work with interest groups and broad public ("social monitoring")

The management of any animal population should include a monitoring in order to assess the effectiveness of the management, enabling the managers to adapt the management in case of adverse results. Similarly, the effectiveness of measures to increase the social acceptance requires its own monitoring. This should be established by regular public surveys in the interest groups and the broad public.

Social-scientific aspects should be included in the monitoring process:

1. Systematic evaluation of reporting about large carnivores should be done in order to be able to reliably interpret changes in attitudes. For example, in Slovenia it was found that the behaviour of individual problem bears was responsible for a large part of negative reporting.
2. Focus groups should be created with participants from different sectors (hunting, agriculture, tourism, nature conservation) in regions with large carnivores presence in order to identify emerging problems immediately.

3. Regular systematic public surveys should be conducted, with special focus on the most relevant interest groups (hunting, agriculture, tourism, nature conservation) in order to detect changes in attitudes at early stages and to evaluate the quality of large carnivores management.

6.6 Integrate local people in the lynx monitoring

The involvement of local people increases amongst other things the feeling of involvement of more than just the person actually involved, but also of their peers. Furthermore, it may empower stakeholders through the co-generation of knowledge and make the research more robust by providing higher quality information input. It also contributes to the dialogue between the local stakeholders/interest groups and the managers/administration and can help to increase the information flow in both directions. For a review of key elements of stakeholder engagement and public participation we refer to Linnell (2013).

Option 6.6.1: Involve interested people at local level, e.g. hunters, foresters and nature enthusiasts in the monitoring of lynx

A scientific robust monitoring is the basis of all meaningful conservation and management actions. However, monitoring results should also be communicated, understood, and accepted by the local population concerned. The performance and the acceptance of monitoring, but also the general dialogue could be improved by integrating individuals from (different) interest groups into the field work by e.g. providing specific web portals designed for the collection and assessment of observation/records of lynx individuals.

Option 6.6.2: Authorities develop an incentive system for the documented presence of lynx at regional or communal level

The presence of lynx can hamper the fulfilment of the required hunting quota or reduce the harvest of ungulate game. State institutions or land users should therefore also consider mitigating conflicts between hunters and lynx through e.g. offering (financial) incentives to hunters' associations who have lynx in their hunting grounds, if in accordance with national legislation. Such a system also offers the opportunity to integrate hunters into the lynx monitoring, e.g. by giving them the burden of onus of lynx presence.

6.7 Secure sustainable damage prevention and compensation systems for livestock damages

The amount of livestock killed by lynx is rather small and generally involves only one victim per attack. However, even the loss of very few animals often results in a hostile attitude towards the carnivore. To mitigate the negative impact of livestock depredation by lynx, the development of a sustainable damage prevention and compensation system is recommended. "Sustainable" in this case means that it must be long-lasting and reliable even if compensations costs are rising; i.e. farmers must not fear every year whether the compensation payments are continued or not.

Option 6.7.1: Secure the general, sustainable governmental compensation of livestock damages caused by lynx

Authorities in charge should establish a system of compensation payments. The presence of a legal obligation would additionally strengthen the sustainability of the system. The amount paid per victim is usually equal to the market price. The payments may be split between different institutions, but there should be a single, clear point of contact for the concerned farmer.

Option 6.7.2: Establish adequate damage prevention measures where livestock damages have been repeatedly confirmed

Lynx attacks on livestock – mainly sheep herds – are on average so rare and unpredictable that no general specific measures to prevent damage is recommended. However, in case of repeated attacks on the same herd, protective measures should be taken. An overview of possible measures and preconditions for the application of a specific measure can be found in Angst et al. (2002).

Option 6.7.3: Secure mechanisms for the advice on and assistance in implementing damage prevention measures by institutions in charge

As already indicated under Option 6.7.2, not all methods of protection of herds against lynx attacks are reasonable in all cases. To assist the (sheep) farmers, the institutions in charge should provide advice on implementing damage prevention measures, e.g. based on Angst et al. (2002).

Option 6.7.4: Link compensation payments to application of damage prevention measures

It is possible to link the payment of compensation to the prior establishment of protective measures. With lynx, it would not be sensible to establish such a condition as a general rule, but only in case of repeated attacks. A benchmark would have to be set, after which further damages are only compensated if adequate prevention measures have been implemented. “Adequate” would need to be defined with regard to (1) the effectiveness of the protective measure, and (2) the effort required putting the protective measure in place.

7 Suggestions for priorities in time and space

Despite the diversity of situations that lynx management is faced with across the Alpine countries, the RowAlps project has identified a set of general management options for the entire Alpine lynx population. Although there may be some regional and national variation in the priority of implementing these management options, suggestions for pan-Alpine priorities in time and space are needed. Therefore, working Group 3 of the RowAlps project identified the level and timing of priority for each of the seven management options (Table 6). The report of the European Commission “Key actions for Large Carnivore populations in Europe²³” provided a basis for defining the level of priority and the timing of implementation for most of the options (marked with an asterisk in Table 6). The remaining ones have been assigned to a level of urgency according to the rating of Working Group 3. The timing of implementation was defined separately for areas with and without established lynx populations.

²³ Boitani, L. et al. (2015): Key actions for Large Carnivore populations in Europe. Institute of Applied Ecology (Rome, Italy). Report to DG Environment, European Commission, Bruxelles.

Table 6: Suggested level of priority and timing of implementation for management options for the Alpine lynx population.

Management option	Level of priority	Timing of implementation
Active genetic management (Option 6.2)	High	> Establish measures: - where necessary and as soon as possible in areas with established lynx populations > Continuous implementation
Foster dialogue among authorities, with wildlife managers, hunters and foresters by establishing information and consultation mechanisms regarding the lynx (Option 6.5)	High	> Establish measures: - as soon as possible in areas with established lynx populations - upon first appearance of individual lynx in areas without established lynx populations > Continuous implementation
Merge eastern and western subpopulations (Option 6.1)	High/Medium	> Establish measures: - within next 10 years (2016-2026) > Continuous implementation
Secure and construct new connection corridors (Option 6.3)	High/Medium	> Establish measures: - where necessary and in accordance with merging eastern and western subpopulations > Continuous implementation
Integrate local people into lynx monitoring (Option 6.6)	High/Medium	> Establish measures: - as soon as possible in areas with established lynx monitoring - from the onset of developing new monitoring systems > Continuous implementation
Prevent and persecute illegal action through law enforcement (Option 6.4)	High/Medium	> Establish measures: - as soon as possible in areas with established lynx populations - upon first appearance of individual lynx in areas without established lynx populations > Continuous implementation
Secure sustainable damage prevention and compensation systems for livestock damages (Option 6.7)	Low	> Establish measures: - in areas with repeated attacks where lynx populations have established > Continuous implementation

Annex 1: Literature

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The WISO Platform thanks the RowAlps Project for the work done, as well as to all the colleagues and the institutions taking part of its developments. The Platform adopts the RowAlps reports “Lynx and Wolf in the Alps: Recommendations for an internationally coordinated management” as part of the WISO Platform report to be accompanied by an introduction as follows and welcomes them as useful contribution to the fulfilment of the WISO Platform mandate.

Both reports should be considered as living documents that should be further developed as new data, approaches or methodologies come to light. The WISO Platform notes that the reports are based on the population level based management suggested by the Large Carnivore Initiative for Europe (LCIE).

The definition of Favorable Conservation Statuses for the entire Alpine lynx and wolf populations and the quantitative values for each Alpine country were elaborated on the basis of one of the suitable approaches available and should be further developed taking into account also the outcomes of the *ad hoc* Working group of the European Commission as well as relevant studies and publications, where appropriate.

The WISO Platform will present the WISO Report to the relevant bodies of the Alpine Convention in 2016, and will look for the opportunity to present it to the *ad hoc* Working group of the European Commission.

Wolf in the Alps: Recommendations for an internationally coordinated management



KORA Bericht Nr. 72

Wolf in the Alps: Recommendations for an internationally coordinated management

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Wolf in the Alps: Recommendations for an internationally coordinated management

Report of the RowAlps Project (Recovery of Wildlife in the Alps) in the framework of the WISO (Wildlife and Society) Platform of the Alpine Convention

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Abstract

The RowAlps (Recovery of Wildlife in the Alps) Project was founded in order to support the Platform “Large Carnivores, Wild Ungulates and Society” (WISO – Wildlife and Society) in fulfilling its Alpine Convention Mandates for the periods of 2013-2014 and 2015-2016: Develop practical goals and management options for the recovery and conservation of wolf, lynx and bear populations in the Alps and present these to the relevant bodies of the Alpine Convention.

Therefore, the overall goal of the RowAlps project is to develop practical goals and management options for the recovery and conservation of wolf and lynx populations in the Alps. To reach this goal three objectives were defined. In brief these objectives are: 1) To review and assess the present situation of wolf, lynx and prey populations in the Alps, the expected development of the populations and discuss challenges in wildlife management as a consequence of the return of the carnivores; 2) To describe mechanisms to achieve tolerance for lynx and wolf for different interest groups and to identify factors defining the tolerance and the potential measures to influence these factors and 3) To assess the output from objectives 1 and 2 and develop management scenarios for the recovery and conservation of favourable wolf and lynx reference populations in the Alps and discuss them with interest groups.

For objectives 1 and 2, each a working group was established with experts and interest groups. For objective 3 a working group with delegated representatives of the country delegations of the WISO Platform was established.

The current report is the product of the working group assigned with fulfilling the 3rd objective. In seven chapters the following contents are presented: 1) Introduction; 2) Framework for large carnivore management; 3) Current situation of the wolf population in the Alps; 4) Discussion, interpretation and assessment of a future Alpine wolf population and main threats; 5) Practical goal; 6) Management options and implications and 7) Suggestions for priorities in time and space.

The RowAlps Project identified its *overall practical* goal as achieving a favourable conservation status (FCS, according to Linell et al. (2008)) of wolf in the Alps. To reach FCS for the Alpine wolf population, *at least 125 packs need to be widely and evenly distributed according to suitable habitat across the Alps* and connected to neighbouring populations. The *main threats* to the present and future Alpine wolf population were identified as human caused mortalities (illegal killing, accidental mortality), livestock depredation, low acceptance and poor management structures. To address these threats, a set of *five general management options* for the entire Alpine wolf population were identified: 1) Secure sustainable damage prevention and compensation systems for livestock damages; 2) Foster dialogue among authorities, with wildlife managers, hunters and foresters by establishing information and consultation mechanisms for the wolf, 3) Integrate local people in the wolf monitoring, 4) Prevent and persecute illegal action through law enforcement and 5) Control of wolf-dog hybrids and domestic dogs. Although there may be some regional and national variation in the priority of implementing these management options, *the level and timing of priority* for each of the five management options were identified.

The current conclusions were elaborated on the basis of the suitable approaches and data available at the time of writing this report.

1. Introduction

1.1 Assignment and context of the present recommendations for an internationally coordinated management

The Platform “Large carnivores, wild ungulates and society” (WISO – wildlife and society) was set up by the X Alpine Conference in 2009 (Evian). Liechtenstein was assigned with the first presidency. Switzerland was allocated the second presidency by the XI Alpine Conference and Italy the third presidency by the XII Alpine Conference.

For the period of 2013-2014 the Platform dealt with the following mandate:

- Development of practical goals and management options for the recovery and conservation of wolf, lynx and (according to availability of funds) bear populations in the Alps and presentation to the relevant bodies of the Alpine Convention;
- Working towards an Alpine-wide genetic monitoring programme for large carnivores;
- Development of a map with the distribution and abundance of the Alpine ibex population in cooperation with the Alpine Ibex Group.

The “spirit of WISO” is based on the Alpine Convention and is expressed by the first president of the Platform, Felix Näscher with the following words:

“To ensure the continued existence of viable populations of large carnivores, regional planning must start taking their needs into account, e.g., by guaranteeing migration corridors, by defining tranquility wildlife areas, by conserving functioning ecosystems, by applying adequate management strategies and measures as demanded by the protocols on “Spatial planning and sustainable development” and “Conservation of nature and the countryside”.

A functioning ecosystem comprises both large predators and their prey species. Therefore, any concept for the conservation and management of wildlife species – be it large carnivores or wild ungulates – has to be based on a holistic and integral approach. Thus, speaking about large carnivores, you have to take into account the status of possible prey populations and of their habitats over the entire area occupied by these species; and, speaking about wild ungulates, you have to reflect the influence of predation by large predators over the entire area occupied by these species: Finally and above all, you have to go beyond a strictly ecological approach.

Any successful determination of development targets, strategies and measures with respect to these wildlife species will have to take it for granted, that economic and social aspects are duly taken into account on an equal level: Sustainable conservation and exploitation of wildlife can only be ensured when respecting and assessing all of these ecological, social and economical parameters, which are determining the system at stake.

Sustainable wildlife management can’t never be a question of purely scientific knowledge – far away from it: Sustainable wildlife management has to be an expression of a will, how to deal with our wildlife species - by taking into account, by balancing and by harmonising ecological, economical and socio-cultural interests: A decision of all stakeholders involved is required - or let’s just say, a decision by society” (Näscher 2009).

To fulfil the overall goal the WISO Platform members understood, that additional expertise is necessary to analyse adequately the data and information of the different countries and to develop

appropriate solutions for the entire Alpine arc. This additional work, which goes beyond the Platform's capacity, is covered by the especially designed RowAlps project¹ for lynx and wolf. The project is financed by the MAVA foundation, Switzerland (Federal Office for the Environment) and Germany (Bundesministerium für Umwelt, Naturschutz, und Reaktorsicherheit). Switzerland coordinates and leads this project. The RowAlps project started in 2012 and will end in 2016.

The Alpine Convention Mandate of WISO for the period of 2015-2016 was adopted at the XIII Alpine Conference in Torino, on November 21st 2014. It focuses on the following tasks:

- *“To finalise drafting of practical goals and management options for the recovery and conservation of wolf and lynx populations in the Alps; to continue the development of practical goals and comprehensive advice for the application of management options in relation to recovery and conservation of bears in the Alpine region; to present all management options to the relevant bodies of the Alpine Convention in 2016.*
- *To develop procedures among the contracting parties concerned, which ensure a transparent flow of information and support decision-making processes as well as the coordination of responding actions for wolves and bears; common interpretations of behaviour of problem bears; and more effective and coordinated conservation actions for the lynxes involving the key stakeholders.*
- *To continue the development of coordinated programmes of genetic monitoring of wolves and bears on an Alpine scale, and to ensure a profound understanding of the genetic risks for the conservation of the lynxes to guide conservation policies in the Alps.*
- *These goals are to be pursued taking into account the results of the RowAlps project and other relevant projects, including EU-funded projects, and exploring synergies with the EU Platform on coexistence between people and large carnivores and other relevant initiatives”* (Alpine Convention 2014).

1.2 Main goals and general orientation of the guidelines „Large carnivores, wild ungulates and society“ of the Alpine Convention

The work of the WISO Platform (and RowAlps) is based on and guided by the WISO guidelines that were adopted by the XI Alpine Conference in 2011 (Slovenia).

The main goal and general orientation of the guidelines is to achieve and conserve the favourable conservation status of the wolf, lynx and bear in the entire Alps. Subgoals and options define the orientation of the WISO Platform to achieve the main goal.

¹ Recovery and conservation of wolf and lynx in the Alps: Options for transboundary conservation and management.

“MAIN GOAL – GENERAL ORIENTATION

Large carnivores and wild ungulates are preserved in balance with their habitat, other wildlife and human interest. Conflicts with human interests are addressed and negative impacts are counterbalanced. [...]

Subgoals

1 - Dialogue: We inform, sensitize, and promote dialogue concerning the relations between wildlife, habitat, and society;

2 - Wildlife populations: We respect the intrinsic value of our wildlife as central components of our environment and steer the development of native wildlife populations in harmonization with their habitat and human interests, with the goal of securing viable wildlife populations;

3 - Wildlife habitat: We support close to nature land-use forms when using mountain pastures, agricultural areas and forests and aim for the conservation and improvement of wildlife habitats in terms of surface and quality;

4 - Integrative sustainable use: We use our wildlife sustainably, in recognition of and in harmonization with the various human interests in protection and use, and we further develop the various land use forms in a balanced manner;

5 - Cooperation: We cooperate transboundary in a cross-sectoral way and harmonize measures, as far as it is needed to reach common objectives, such as the amelioration of living conditions for wildlife species or the prevention of conflicts as regards different user interests as well as compensation of damages” (WISO 2011).

The WISO (wildlife and society) Platform, takes the role of a “Think Tank”. WISO supports the member states and decision makers on a national and international level to achieve and conserve the favourable conservation status of the lynx, wolf and bear in the entire Alps. A special focus is given to cross border issues, international cooperation and necessary harmonization of processes relevant for a population level management.

1.3 Goals of the RowAlps project and current specification of the tasks

The overall goal of the RowAlps project is to develop practical goals and management options for the recovery and conservation of wolf and lynx populations in the Alps. These suggestions will support WISO to fulfill its current mandate.

To reach this goal, three objectives were defined and for each of them a working group was established.

Objective 1: To review and assess, based on available scientific publications and reports, statistical materials and up-to-date experience, the present situation of wolf, lynx and prey populations in the Alps, the expected development of the populations and discuss challenges in wildlife management as a consequence of the return of the carnivores.

Objective 2: To describe mechanisms to achieve tolerance for lynx and wolf for different interest groups and to identify factors defining the tolerance and the potential measures to influence these factors.

Objective 3: To assess the output from objectives 1 and 2 and develop, considering these biological-ecological and socio-economic findings, management scenarios for the recovery and conservation of favourable wolf and lynx reference populations in the Alps, discuss them with interest groups (in the frame of the WISO Platform), and report to the relevant bodies of the Alpine Convention.

These recommendations are based on the reports of the RowAlps objectives 1 and 2, further on the fact finding of the WISO Platform, on inputs of the members of working group 3 of the RowAlps project and finally on different documents, that have been drafted by WISO since its establishment in 2009.

The overall goal and objectives were fine-tuned during the discussions of the RowAlps workshops as well as the WISO Platform meetings during 2014. The working groups of objective 1 and 2 produced two separate reports².

1.4 Management definition

The members of the RowAlps project define management as follows: “Management is any goal-oriented and deliberate intervention within the existing legal framework, carried out by an authorised or mandated actor. The WISO Platform defines management as a value-neutral term that can embrace a wide variety of involvements with large carnivores, their wild or domestic prey species, and habitats or with people. Regarding the carnivores, it could include activities such as translocation and reintroduction, culling and capturing, or also intentional (temporary) non-intervention, but implies always, as it is goal-oriented, a kind of monitoring. Regarding society, it could include activities such as communication, participation, compensation and damage prevention and social monitoring.”³

Management in the present recommendations is understood as: All legal activities in the biological and socio-political sphere with the goal of achieving a favourable conservation status of lynx and wolf:

- on a biological level “management” includes different actions such as conservation, maintaining habitats, lethal removal of single specimens which e. g. are posing a threat to the human population (under the strict conditions laid down in § 16 of the Habitats Directive and the Bern convention) and other actions,
- on a socio-political level “management” means also dialogue, communication and cooperation.

1.5 Scope of the recommendations

The geographical focus for the present recommendations is the Alpine arc. The overall management of the wolf across the Alpine arc focuses on international cooperation, whereas the concrete management options and strategies are understood as a transboundary framework.

² RowAlps report objective 1: The recovery of wolf *Canis lupus* and lynx *Lynx lynx* in the Alps: Biological and ecological parameters and wildlife management challenges. April 2015
Row Alps report objective 2. December 2014

³ Workshop of the working group 3 of the RowAlps project, Vienna, 6th – 7th December 2012

1.6 Addressees

These recommendations address in the first place the official authorities of all member states of the Alpine Convention responsible for strategic planning and in charge of concrete actions concerning the conservation of large carnivores and wild ungulates. The recommendations provide a basis for decision-making regarding:

- strategic planning activities;
- concrete actions to balance large carnivores and wild ungulates with their habitat, other wildlife and human interest; as well as to address conflicts with human interests and counterbalance negative impacts.

Furthermore, they may serve as orientation for all non-governmental actors involved in wildlife management and finally as common vision for the realization of the overall goal to achieve a favourable conservation status of the wolf throughout the Alps.

More detailed reports, good practices, links on initiatives, references are available on the Alpine Convention web site⁴ and MALME website⁵.

2 Framework for large carnivore management

2.1 Legal framework of international and national treaties on large carnivores and population level management

Large carnivores have populations distributed across several countries and can have large individual home ranges, often >100 km². Therefore, legal instruments to protect these species need to be coordinated at an international level, and several international treaties have been established to address transboundary conservation.

The EU Habitats Directive

The EU Habitats Directive ("Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora") is a European Union directive adopted in 1992⁶. All the large carnivore species as well as their habitat are strictly protected by the Habitats Directive (annex II, which requires Natura 2000 sites, and annex IV). Wolf and brown bear, but not lynx, are additionally *designated as priority species*.

"Formally, the Habitats Directive does not explicitly specify that Favourable Conservation Status (FCS) should be achieved at the population level. Its reporting routines require that FCS be evaluated within each country (or within each biogeographical region present within each country), indicating that its intention is to operate on a national or sub-national scale. This scale of consideration may be suitable for a wide range of smaller species, but large carnivores present a wide range of very special challenges. As large bodied top-predators they naturally move over very large areas and occur at relatively low densities. This implies that many (maybe most) countries will never be able to host enough individuals to have a population that can reach FCS. In order for the intention of the Directive

⁴ <http://www.alpconv.org/en/organization/groups/WGCarnivores/default.html>

⁵ http://www.kora.ch/malme/20_malme/home/index_en.html

⁶ http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm

to be achieved for a species group like large carnivores, it must consider spatial scales that span borders. This is actually specified in the Directive's preamble as one of the prime objectives of the Directive. These population level management plans can simply be viewed as an instrument to achieve this goal. The Commission also says in its technical specifications for the tender of this project that "coordinating the management across national boundaries might be the solution to maintain viable populations over the long-term, an approach that is also important to put large carnivore conservation into the broader context of biodiversity conservation". A certain legal clarification is, however, required from the European Commission concerning the proposed practice of attaching favourable conservation status assessment to the population level, which in some cases may free member states from the obligation to achieve it on their own" (Linnell et al. 2008).

Formal requirements towards EU member states are more than "just avoiding extinctions". The requirement is to reach the Favourable Conservation Status (FCS), based on two reference values: Favourable Reference Range (FRR) and Favourable Reference Population (FRP). The *"Member States shall undertake surveillance of the conservation status of the natural habitats and species referred to in Article 2 with particular regard to priority natural habitat types and priority species."* (Article 11, EU Habitats Directive).

On behalf of the European Commission, the Large Carnivore Initiative for Europe elaborated the "Guidelines for Population Level Management Plans for Large carnivores" in 2008. The goals of these guidelines are:

1. To shift the focus from the species and the management unit to the (meta-) population.
2. To interpret FCS-term „Favourable Conservation Status“ for correct and concrete use.
3. To recommend „best management practices“ for large carnivores.

The Natura 2000 network was established under the Habitats Directive and comprises of a series of protected areas within the European Union (Emerald-Network for Switzerland and Liechtenstein).

The Bern Convention

All Alpine States and the European Union have signed the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). It lists wolf and brown bear as strictly protected (Appendix 2), while lynx is listed as protected (Appendix 3) together with the ungulate species. For species in Appendix 3 hunting is allowed as long as the population is not threatened.⁷

"The Bern Convention places considerable emphasis on the need to foster transboundary approaches in the preamble and in articles 1, 10 and 11. Recommendation 115 (2005) also calls for countries to work towards transboundary action plans for large carnivores, and the topic was given considerable attention in a workshop held in Slovenia in 2005 (Bath 2005)" (Linnell et al. 2008).

The Bonn Convention

Furthermore, the Alpine countries are signatories to the Convention on the Conservation of Migratory Species of Wild Animals (CMS, Bonn Convention)⁸, which is specifically tailored to migratory species that cross international borders. The Bonn Convention even allows for states sharing migratory populations to sign legally binding treaties to govern the management of these

⁷ WISO Platform. Results of fact finding in the frame of the Platform, "Large Carnivores and Wild Ungulates". 2010

⁸ <http://www.cms.int/>

species. Although the movements of large carnivores across borders does not follow the strict definition of seasonal migration, it may be worthwhile exploring the potential for use of this convention, which has already been applied to several similar issues.

Whereas given that threatened habitats and species form part of the Community's natural heritage and the threats to them are often of a transboundary nature, it is necessary to take measures at Community level in order to conserve them:

“The combined weight of the Habitats Directive and these two conservation conventions should be enough to motivate EU countries to develop population level management plans, especially if in so doing they will be permitted to adopt more flexible management practices than those allowed by a strictly national perspective. Furthermore, the Bern and Bonn Conventions should be useful frameworks to induce non-EU countries to take part in these plans. Although many Bern Convention signatories have taken reservations for wolves and bears concerning their placement on appendix II – these species are still covered under the Conventions general goals as expressed in articles 1 and 2” (Linnell et al. 2008).

The Alpine Convention

The Alpine Convention is an international treaty (convention) for the protection of the Alps. It was signed beginning from 1991 by the eight countries of the Alpine Arc: Austria, France, Germany, Italy, Liechtenstein, Monaco, Slovenia and Switzerland and the European Community. Every two years is conducted an Alpine Conference in the country holding the presidency.

The Convention works with integrated policies and approaches for the sustainable development of the Alpine Space. Twelve key themes and out of them eight protocols, support the parties to navigate the implementation highly complex sustainable developments in the Alps.

The Permanent Committee and the competent administrations are the main institutions primarily responsible for the Convention implementation. Working groups, platforms, committees etc. support and supervise the implementation of the Convention. One Platform of the Convention is the WISO (Wildlife and Society) which deals with large carnivores and wild ungulates.

Main themes and the protocols with relevance for large carnivores and wild ungulates in the Alpine Convention are

1. Spatial planning
2. Nature protection and landscape conservation
3. Mountain agriculture
4. Mountain forestry

Protocol „Spatial planning and sustainable development“

Article 3 of the protocol aims at considering of the criteria for environmental protection in the policies for spatial planning and sustainable development:

The spatial planning and sustainable development policies aim to achieve swift harmonisation of the economic interests with the needs for protecting the environment, with particular attention inter alia to:

- a) safeguarding and restoring the ecological balance and the biodiversity of the Alpine region, [...]
- d) the protection of ecosystems, the species and rare landscape elements

And Article 9 of the protocol asks the countries that spatial and sustainable development plans and/or programmes include, at the most appropriate territorial level and taking account of the specific territorial conditions,: [...]

4. Protection of nature and the landscape

a) delimiting of the areas for protecting nature and the landscape, and also for safeguarding the water courses and other vital natural resources,

b) delimiting of tranquil areas and areas in which construction of buildings and infrastructures is restrained or prohibited, as are other damaging activities.

Protocol „Conservation of nature and the countryside“

The objective of this Protocol is to lay down International laws, implementing the Alpine Convention and also taking the interests of the local population into account, in order to protect, care for and, to the extent necessary, restore nature and the countryside, in such a way as to ensure the lasting and widespread functional efficiency of the ecosystems, the conservation of countryside elements and wild animal and plant species together with their habitat, the regenerative ability and lasting productivity of natural resources, and also the diversity, specificity and beauty of the natural and rural landscape; and also, in order to encourage cooperation between the contracting Parties for these purposes.

The Contracting Parties undertake to cooperate particularly for: map surveying, drawing the boundaries and then managing and controlling protected areas and other natural and rural elements of the landscape worthy of protection, interconnecting a network of biotopes, defining landscape models, programmes and/or plans, preventing and rebalancing damage to nature and the landscape, systematically monitoring nature and the countryside, scientific research, and any other measure for protecting wild animal and plant species, their diversity and their habitat, and for defining the relevant comparable criteria to the extent that this is necessary and functional (Art. 3.1).

The Contracting Parties undertake to pursue the measures appropriate for preserving the indigenous animal and plant species with their specific diversity and in sufficient populations, particularly ensuring that they have sufficiently large habitats (Art. 14.1).

Finally the Contracting Parties shall undertake to promote the reintroduction and distribution of wild, indigenous animal and plant species and also subspecies, breeds and ecotypes, on condition that there are the necessary prerequisites and, by doing this, there is a contribution to the preservation and strengthening of those species and that no effects unsustainable to nature and the landscape, or to human activities, are caused (Art. 16.1). Scientific knowledge is to be applied for reintroducing and distributing these species. The Contracting Parties shall agree on common directives in this respect. Following the reintroduction, it will be necessary to control and, if required, regulate the development of these animal and plant species (Art. 16.2).

Protocol „Mountain farming“

In Article 13 of the protocol the Contracting Parties agree that the complementary nature and partial interdependence of farming and forestry in mountain areas necessitate an integrated approach. Consequently, they shall encourage:

(a) forestry compatible with nature both as an additional source of revenue for farms and as a sideline activity for farm workers;

(b) consideration of the protective, productive and recreational as well as the environmental and biogenetic functions of forests, in relation to farmland, taking account of the specific local conditions and in harmony with the countryside;

(c) regulation of grassland farming and of the game population, to avoid any intolerable damage to forests and crops.

Protocol „Mountain forests“

The Contracting Parties undertake to also consider the objectives of this Protocol in their other policies. This primarily applies to the following areas: [...]

b) Populations of game. The game population is to be contained within limits permitting the natural reforestation of the mountains by indigenous trees, without having to take recourse to special protective measures. In the border areas, the Contracting Parties undertake to harmonise their measures for regulating the game animals. To restore a system of natural selection on the hoofed species, and also in the interest of protecting nature, the Contracting Parties shall encourage the reintroduction of predators, to an extent appropriate for the general needs of the region (Art. 2).

CITES

The Convention on International Trade in Endangered Species of Wild Fauna and Flora, is an international agreement between governments to ensure that international trade in specimens of wild animals and plants does not threaten their survival. It came into force in 1975. Wolf is listed in Appendix 2 (www.cites.org). In the EU countries CITES is implemented by Council regulation (EC) No 338/97.

The national laws on hunting and on large carnivores

In the Alpine countries wildlife is managed through legal and practical means such as protective laws and selective hunting.

The wolf is strictly protected in all Alpine countries. This status is however subject to restrictions in some countries in order to reduce conflicts with livestock husbandry.

In Germany however there are no such restrictions but only exceptions from the rule (strictly protected) in compliance with Art 16 of the Habitats Directive. In Switzerland, livestock raiding individuals are selectively removed. In France and Slovenia, exceptional culls are permitted.

In France, wildlife and environmental monitoring are carried out by the Office National de la Chasse et de la Faune Sauvage ONCFS. The role of hunting in Italy is primarily to control wild boar, red deer and roe deer populations (Apollonio et al. 2010). Switzerland has licence hunting across the Alpine range, with 41 federal wildlife reserves where hunting is banned (Imesch-Bebié et al. 2010). Ungulate management and hunting practices in Germany are carried out with the objective of reducing and preventing damage to crops and forests. There is a federal hunting law, but the 16 "Bundesländer" all have additional regulations (Wotschikowsky 2010). Austria uses the "Reviersystem" similar to the system in Germany; the Austrian "Bundesländer" are responsible for legislation and management of game (Reimoser & Reimoser 2010). The current Slovenian Law on Wildlife and Hunting controls the wildlife management system in Slovenia (Adamic & Jerina 2010).

Table 1: Legal status of the wolf, restrictions to the status and authority in charge of wolf conservation and management in the Alpine countries.

Country	Legal status	Management interventions	Authority in charge
France	Strictly protected	Removal of stock raiding individuals (<i>tir de défense</i>). A yearly defined number of individuals are removed (<i>tir de prélèvement</i>)	Ministère de l'écologie, du développement durable et de l'énergie
Italy	Strictly protected	No derogation has ever been requested for culling under article 16 of the Habitats Directive.	Ministry of Environment; however the implementation is left to the regions.
Switzerland	Strictly protected (young wolves)	Selective removal of stock raiding individuals. Criteria for population regulation if predation impact is too high.	Federal Office for the Environment FOEN; the cantons for the implementation of the wolf concept.
Liechtenstein	Strictly protected		Amt für Umwelt
Germany	Strictly protected under the jurisdiction of the Federal Nature Conservation Act.		Nature conservation authorities of the Länder (in Saxony also the hunting authorities). In some Länder the regional ministries of the environment are in charge, in other Länder responsibility is further delegated to the district administrations.
Austria	Wolf is mainly subject to the district's hunting laws, but enjoys a year-round closed season.		Hunting and nature conservation authorities of the provinces.
Slovenia	Strictly protected since 2004 (before quota hunting from October to February)	Exceptional culls permitted to decrease conflicts with agriculture.	Ministry of Agriculture and Environment

2.2 Administrative framework concerning current management of large carnivores at national and local level of Alpine countries

The development of a national wolf management plan has been addressed by all Alpine countries. Wolf management plans were elaborated in France as early as 1993. The Italian Ministry of Environment with technical support of the Istituto Superiore per la Protezione e la Ricerca Ambientale ISPRA has established National Action Plans for brown bear and wolf in Italy (Anonymous 2012). A concept for the management of wolf in Switzerland was developed in 2004 (BUWAL 2004) and revised in 2008 and 2010 (BAFU 2008, 2010).

Several Länder in Germany including Bavaria have developed regional wolf management plans. These plans, although called management plans, mainly deal with regional conflict mitigation and management competences. Slovenia has a strategic management plan and a five-year action plan is currently being implemented. Regional management plans for wolf exist in Germany and Switzerland.

Table 2: Countries with operative management plans for large carnivores and for the whole Alpine part of the population ✓ or regionally [✓].

Species	France	Italy	Switzerland	Liechtenstein	Germany	Austria	Slovenia
Wolf	✓	✓	✓		✓		✓
Lynx			✓		✓		
Brown bear	✓	[✓]	✓		✓	[✓]	✓

All Alpine countries have a decree that defines, which species are protected and which ones are hunted. While e.g. the authority in charge is the state in France, in Austria the federal provinces (Länder) are responsible for large carnivores and wild ungulates. In France, wolf and bear management are organized at the national level through national action plans. The actions planned at national level are put in practice by departmental authorities and coordinated at the regional level. In Switzerland and Italy the general conditions are defined in the national laws, but some species are managed on cantonal or regional level, respectively. In Switzerland all three large carnivores are protected by federal law. The federal law also gives the general guidelines about wild ungulate management, but delegates the management itself to the cantons. In Italy large carnivores are protected on ministerial level and the ungulates are contained in the regional hunting law. In Germany all large carnivore species are strictly protected by the Federal Nature Conservation Act. The administrative structure of huntable species in Bavaria is divided in three levels: local, the district and state level (Ministry of Food, Agriculture and Forestry). In Austria, the three large carnivores are managed under the hunting law with year-round closed hunting season. In Slovenia, protected species (bear, wolf, lynx) are regulated by nature protection legislation, game (chamois, ibex, roe deer, red deer, wild boar, mouflon) are regulated by hunting legislation.⁹

France, Switzerland, Germany and Austria have established large carnivore management boards with representatives of GOs, NGOs and scientists as discussion forums on regional and/or national level. The aim is an objective discussion about emerging problems and possible solutions to serve conflict management.¹⁰

In 2006, the Ministries of Environment of Italy, France and Switzerland signed an “italo-franco-suisse collaborative protocol for the management of wolf in the Alps” (Ministerio dell’Ambiente e della Tutela del Territorio et al. 2006). This protocol takes into account aspects of the Habitats Directive and Bern Convention as well as the existing national management plans with a common goal of re-establishing and protecting a viable wolf population in the Alpine arc.

Liechtenstein will in future be integrated in the management plans of Switzerland.

Wolf and lynx are strictly protected by international and national laws, but with regard to practical management, almost all countries having substantial populations of these carnivores are applying some regulations allowing for exceptional removals of problem animals. For the wolf, France is applying the principles of “tir de défense” and “tir de prélèvement”, and Switzerland has set limits for how many livestock a wolf is allowed to kill before it can be lethally removed.

⁹ WISO Platform. Results of fact finding in the frame of the Platform, “Large Carnivores and Wild Ungulates”. 2010

¹⁰ WISO Platform. Results of fact finding in the frame of the Platform, “Large Carnivores and Wild Ungulates”. 2010

2.3 Human developments in the Alps

Since 1871, the resident human population in the Alps has almost doubled, from 7.8 million to 15.2 million people (Bätzing 2015). However, the population development has varied hugely within the Alps and the population distribution became much more uneven: the majority of people live below 500 m. Areas along major transport routes have become urbanised and cities at the edges of the Alps have become “commuter towns” for the metropolises surrounding the Alps. Tourist destinations have grown, too. The population has increased especially in the western parts of the eastern Alps. The population in higher elevation areas has decreased, mostly because agriculture has become unprofitable due to limited mechanisation. The population decrease was most prominent in the Italian Alps (except South Tyrol), eastern Austrian Alps, and some regions in the French Alps. Young people and families moved away, and the population in these communities is considerably over-aged. A further population decrease is expected in areas with unfavourable economic conditions.

Tourism in the Alps has been stagnating on a high level since the early 1980s. About 60 million people visit the Alps every year for daytrips and an additional 60 million people stay for 370 million nights in the Alps every year (Siegrist 1998). However, tourism is spread unevenly across the seasons and across the Alps (37% of municipalities in the Alps offer no tourist beds at all; Price et al. 2011).

The influence of tourism on large carnivores and wildlife in general is twofold: Firstly, tourism requires infrastructures (e.g. transport infrastructure, ski slopes, or golf courses), which influences the landscape and the habitat of wildlife. Secondly, touristic activities (e.g. hiking, skiing, paragliding, but also added traffic from visitors) create disturbances for the local wildlife. Nonetheless, the populations of ungulates have increased throughout time. Large carnivores have a high capacity to adapt to human activities. Wildlife and especially large carnivores also represent a chance for tourism as visitors see them as the embodiment of pure nature and untamed wilderness. Wildlife tourism is however weakly developed in the Alps.

2.4 Ecological framework

Habitat loss and fragmentation are the leading human-caused deterministic factors affecting wildlife populations with effects being caused by e.g. altered connectivity or increased edge effects (Mills 2007).

The fragmentation of the landscape in Europe is increasing, which has various negative effects on wildlife (e.g. barrier effect, loss of habitat, increased numbers of traffic collisions). Nevertheless, the Alps still feature some of the largest unfragmented low-traffic areas in Central Europe but valley floors can be just as heavily settled and fragmented as the lowlands surrounding the Alps and present considerable barriers for animal movements.

The Alps are one of the best-known mountain ranges as well as being one of the richest in biodiversity, it is, however, also one of the most densely populated. The traditional tool used to conserve biodiversity and the natural environment has always been the creation of protected areas. However, it has become increasingly obvious that a majorly important aspect in the conservation process is to connect protected areas to one another to allow the migration of species across the entire Alpine range.

Besides the extent and quality of forests (which have improved over the past 100 years in the Alps), the connectivity between forest patches is decisive for far-roaming terrestrial species.

Forests in the Alps have been strongly overexploited in the 18th/19th century, but have recovered and forested areas have expanded again in the 20th century. About 52% of the Alpine area is forested, and “forest creation and management” contributes the majority to recent changes in land cover (EEA 2010).

The realisation of an ecological continuum and the reduction of fragmentation lead to concrete spatial links (corridors) and measures in favour of the establishment of a pan-alpine ecological network (ECONNECT 2011).

Genetic flow across the whole Alpine range is important. Across the whole Alpine range a coordinated and transnational approach is needed in accordance with the legal framework provided by the Alpine Convention. Together with the “Ecological Continuum initiative” and the “Platform Ecological Network” of the Alpine Convention, Econnect created the Alpine ecological network to join efforts focussing on the Alpine massif as a whole in order to create a functioning ecological network in the Alps to contribute to conserve the extraordinary rich alpine diversity.¹¹

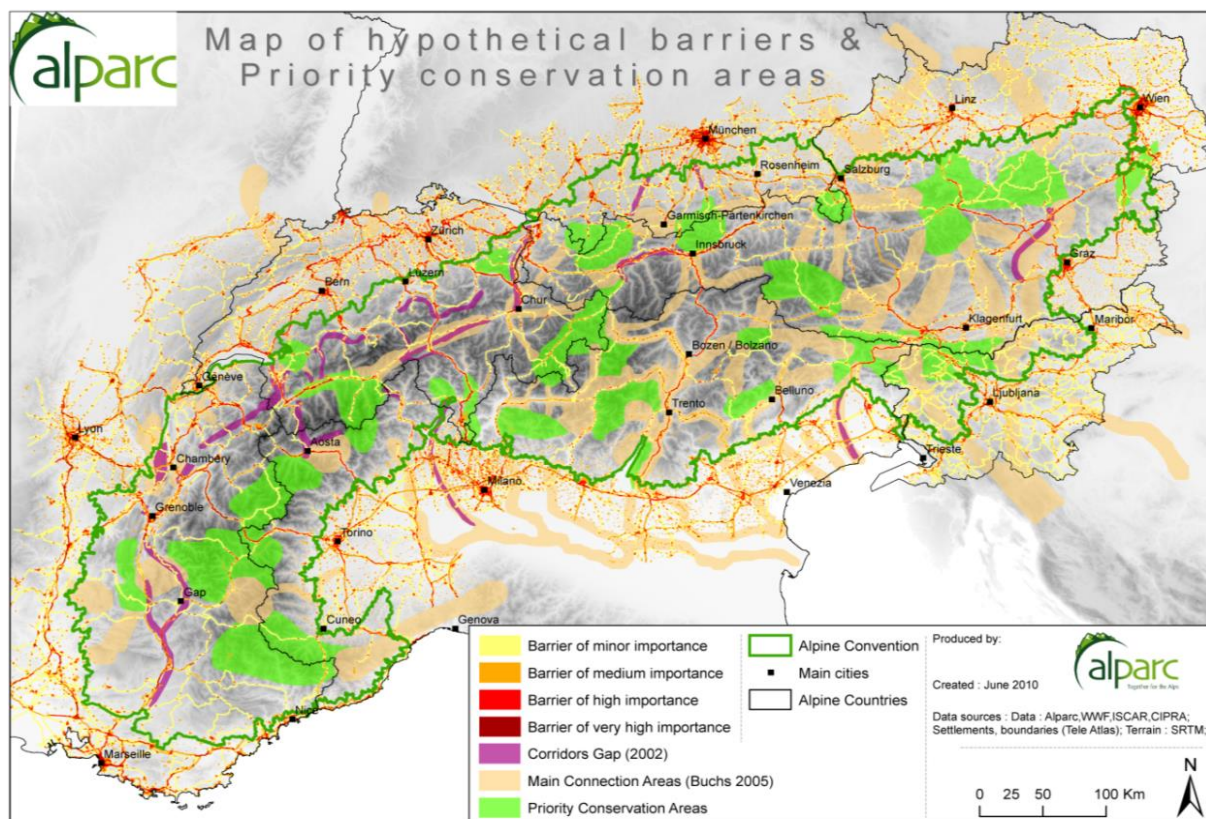


Fig. 1: Map of barriers and priority conservation areas. The map was based on expert opinion expressed during a workshop for the Ecological Continuum Initiative in 2010.

Marucco (2011) calculated habitat suitability models for the wolf in the Alps and studied the connectivity within the Alpine area. The main unit in the analysis were not individual wolves, but packs, because they represent the main reproductive unit in wolf social dynamics (Mech & Boitani 2003).

“Wolves can easily cross roads and highways, as documented by many studies (e.g. Boyd & Pletscher 1999, Ciucci et al. 2009); therefore, a single road is not usually identified as a barrier for wolf dis-

¹¹ <http://www.alpine-ecological-network.org/the-alpine-ecological-network>

persal. However, in Italy wolves are often killed by car accidents (Lovari et al. 2007), especially if they settle a territory in a region with a high road density (e.g. Avanzinelli et al. 2007). Therefore, road density is a major limitation to pack settlement more than to wolf dispersal. The report of ECONNECT documented that not just road density is a variable negatively related to wolf presence, but also human settlements, low forest cover and high rock elevation presence (Marucco 2009). Connectivity results need also to be interpreted within the strict regulations of wolf sociality and dispersal movement patters, very different than for the other solitary large carnivores” (Marucco 2011).

The lowest amounts of connectivity (i.e. barriers) were found mainly in the west-central Alps, and in Switzerland (Fig. 2). These findings coincide with the wolves’ observed recolonization of the Alps from the Apennines, which has slowed down over the the indicated barriers in the recent decade (Marucco 2011).

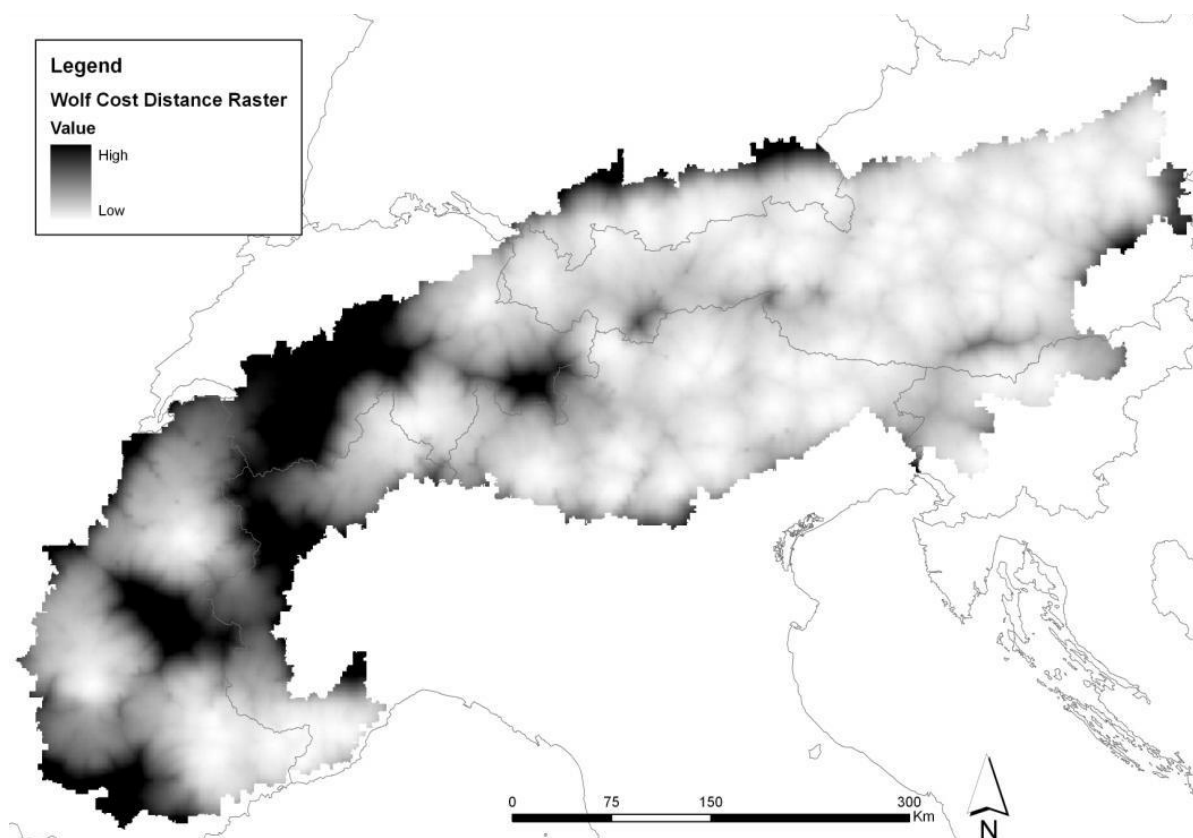


Fig. 2: The wolf cost distance raster. For every cell the least accumulative cost distance over a cost surface to the identified source locations was calculated. Light areas indicate higher connectivity, dark areas indicate barriers (Marucco 2011).

However, connectivity is also affected by management fragmentation, which is a type of fragmentation often overlooked (Linnell et al. 2007, cited in Marucco 2011), but crucial within the Alps with its many international and intranational borders. Switzerland was by then the only country, in which the possibility existed to remove “problem individuals”. The identified barriers (Fig. 2) may therefore not only represent barriers in the landscape, but also management barriers for wolf expansion towards the Eastern Alps. The present recommendations aim at reducing such management fragmentation.

“Finally, wolf connectivity over the Alps needs to be analysed in a wider context, taking into consideration that the alpine wolf population was naturally generated 20 years ago through natural dispersal from the south-western Apennines (Fabri et al. 2007). The connection with the Apennine population is constituted by an ecological corridor represented by the Ligurian Apennines Mountains, which is fundamental to be maintained in order to guarantee enough genetic diversity in the wolf Alpine population (Fabri et al. 2007). Moreover, an interesting slight connection has been documented with the Dinaric population from Slovenia, and the Carpathian wolf population (Rauer & Groff, pers.comm.). Spatial analysis of potential connectivity within these areas and the Alps, and characterisation of the barriers by their origin, size, shape and degree of permeability with an assessment of possibilities to diminish them, would be extremely important to allow a future wolf metapopulation over the different mountain chains in Western-Central Europe” (Marucco 2011).

3. Current situation of the wolf population in the Alps

3.1 Return of the wolf to the Alps and population development

The historic decline and eventual eradication of the large carnivores in the Alps between 1800 and the early 1900 proceeded in parallel and was related to the expanding human population and the over-exploitation of natural habitats and resources, including forests and game. Increasing numbers of sheep, goats, cattle and horses affected the forests negatively due to browsing and out-competed the wild ungulates. The large predators were forced to kill livestock and were therefore persecuted, encouraged by governmental bounties. However, hunting alone did not lead to the eradication of the large carnivores. Only the massive intervention at the level of the landscape (forests) and the substantial reduction of wild ungulates led to the final eradication of lynx and wolf (Zimen 1978, Breitenmoser 1998a).

A radical change in forest management and the growing sensitivity of people for the protection of nature in the first half of the 20th century were the basis for the recovery of the forests (Breitenmoser 1998a). Wild ungulates started to recover and expand from remnant source populations after they were granted a certain legal protection (change of hunting legislation). Their renaissance was supported by numerous translocations and reintroductions. A swift increase in all wild ungulate populations – which is still continuing for roe deer, red deer and wild boar in many regions – was the result. The ecological recovery was facilitated by industrialisation, which drew people away from rural areas. As a consequence, the number of goats and sheep in the Alps declined drastically in the first half of the 20th century.

All these factors prepared the ground for the return of lynx and wolf to the Alps. The return of the wolf was a consequence of the improved protection of the remnant populations in the Apennine, in the Dinaric Range and in eastern Europe. The first wolves arrived in the early 1990s from the Italian population and settled the south-western Alps of France and Italy.

Wolf made a remarkable come-back to the Alps. Within only two decades the species settled the French Alps from the Italian Apennines and started to recolonise the Swiss Alps. Wolves are also arriving from the Dinaric, Carpathian and possibly also from the Central European Lowland populations. The Alps are situated in between of several wolf populations and could act as a cross-breeding area in the future. Thanks to non-invasive genetic monitoring, this process can be shown –

given the data are processed equally between the different countries. Monitoring of the recolonisation of the Alps by the wolf is requiring cross-border cooperation and the regular exchange of monitoring data.

3.2 Present status and distribution of the Alpine wolf population

The Alpine wolf population was assessed as „endangered“ according to the IUCN red list assessment, but with an increasing population trend. Low acceptance, habitat loss due to infrastructure development, persecution, hybridisation with dogs, poor management structures and accidental mortality were listed as the most relevant threats (Boitani et al. 2015).

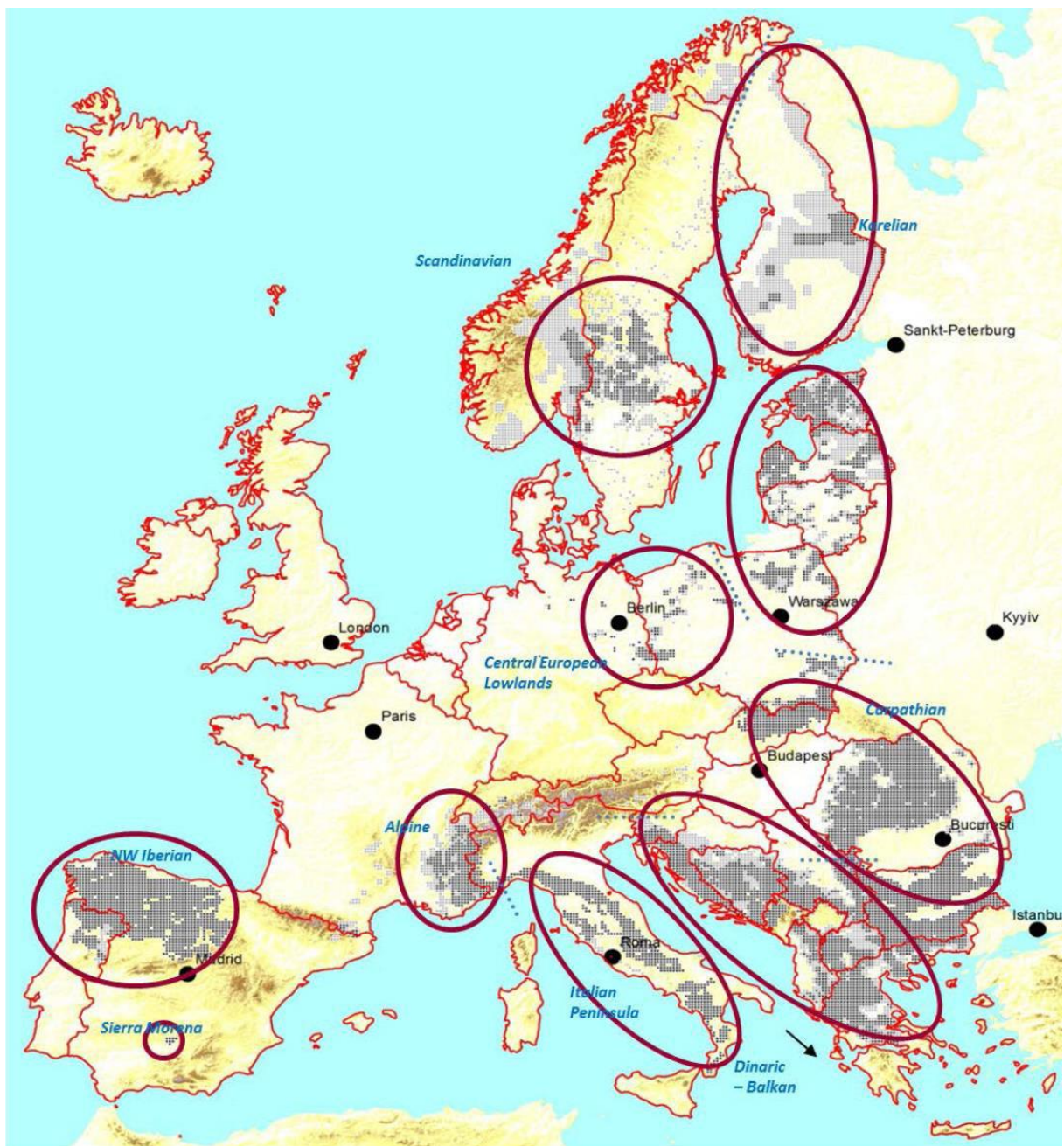


Fig. 3: Wolf distribution in Europe 2011. Dark grey cells: permanent occurrence, light grey cells: sporadic occurrence. Red borders mark countries for which information was available. Circled are the populations as defined by the IUCN/SSC Large Carnivore Initiative for Europe. Source: Kaczensky et al. 2013a.

The western Alps have been recolonised by wolves from the Italian population which had experienced a bottleneck and was reduced to about 100 individuals in the 1970s (Zimen & Boitani 1975). The recolonisation of the Eastern Alps is not as advanced as in the Western Alps. Pioneers in the Eastern Alps came from various source populations. The Alps will become a melting pot of various European wolf populations, enhancing the genetic diversity of the overall Alpine population. In 2009/2010, the Alpine wolf population was estimated to be at least 160 wolves or 32 packs (Kaczensky et al. 2013a). According to the Wolf Alpine Group (WAG), in 2014 the wolf population increased to at least 35 packs and six pairs were recorded.

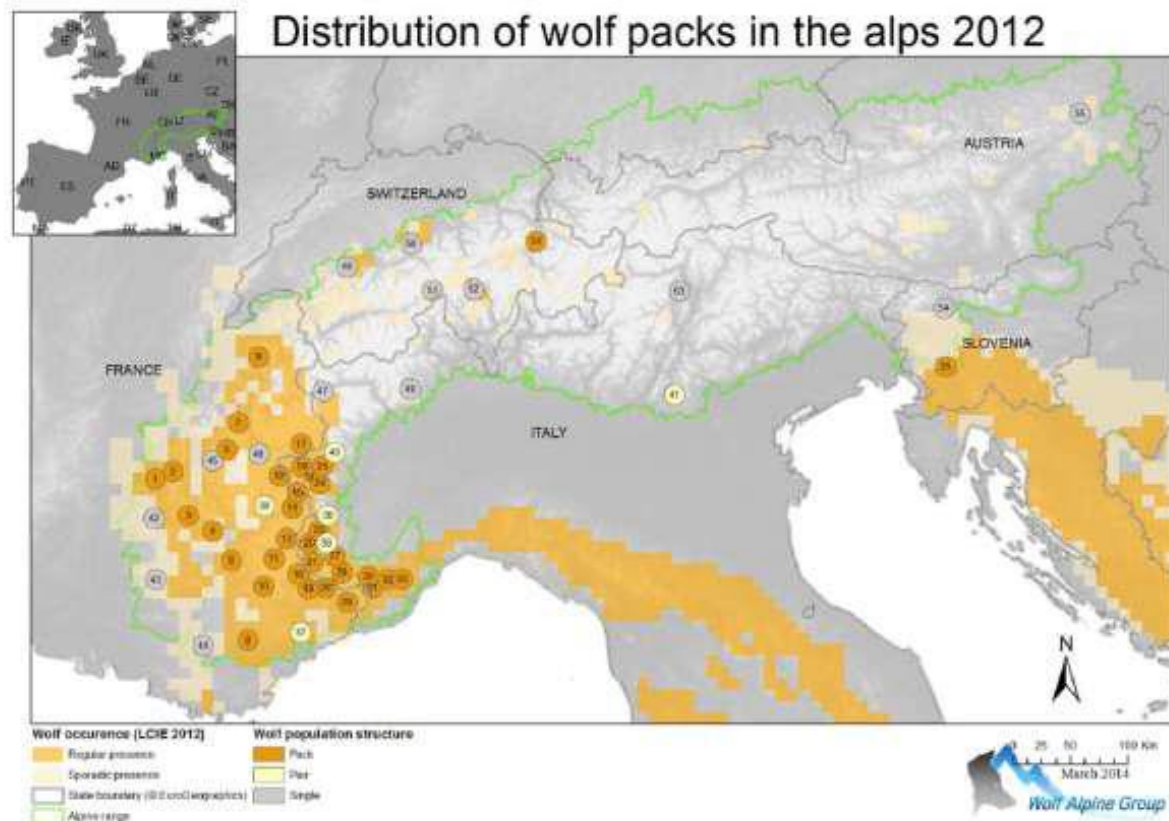


Fig. 4: Distribution of packs, pairs and single wolves in 2012 in the Alps that hold a territory for at least two years (WAG 2014).

Wolves in France are mostly found in the Alpine region (Marboutin 2013a). Census results in 2009 resulted in the identification of 13 wolf pack territories and 7 transboundary pack territories straddling France and Italy (Marboutin 2013a). By the 2010 season, the population estimated through snow tracking was around 68 wolves. Wolf presence study in 2014 showed an increase of wolf presence (ONCFS 2014).

The population in the Italian Alps was estimated at 60-70 wolves in 2010-2011 (Marucco & Avanzinelli 2012), distributed across at least 12 packs, in addition to 7 transboundary packs shared with France. The Italian and Dinaric wolf population were separated for centuries, but in 2012 the first contact between these populations was documented (Boitani & Marucco 2013).

In Switzerland, a total of 60 wolves (14 females) were genetically identified from 2005-2014, but the first reproduction was only confirmed in 2012 (von Arx & Manz 2013). 24 wolves were genetically identified in Switzerland between October 2012 to September 2014.

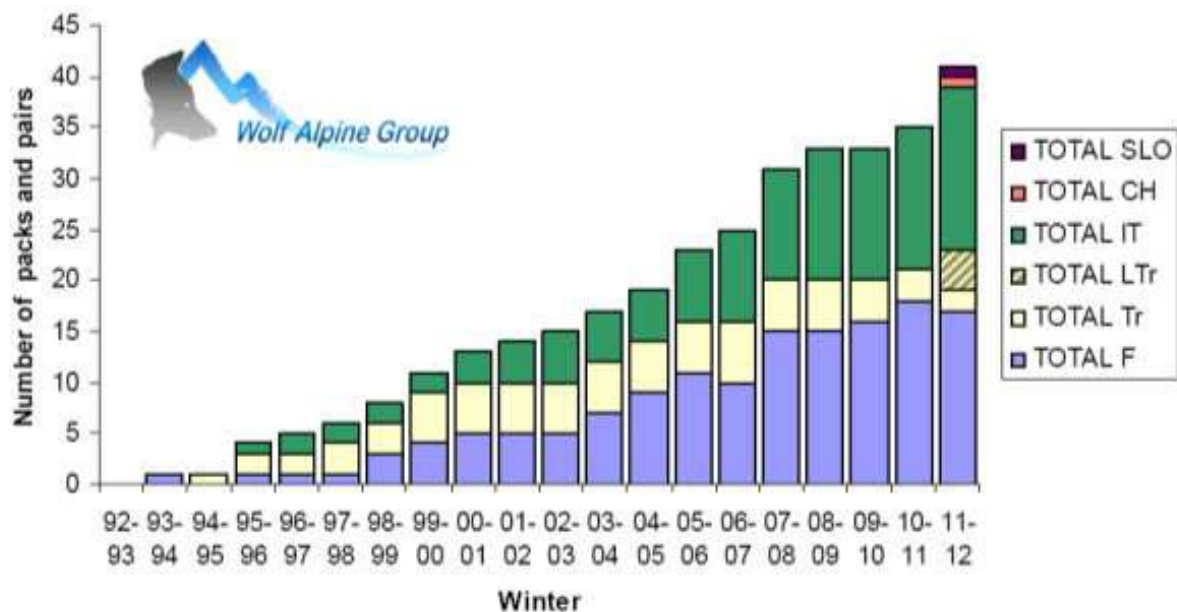


Fig. 5: Number of wolf packs and pairs across the Alpine countries (WAG 2014). NB: packs and pairs = at least 1M + 1F for two consecutive winters or breeding evidence next summer. F : France; IT : Italy, CH: Switzerland; SLO: Slovenia, Tr: transboundary, LTr: likely transboundary.

Wolves are mainly present in the northern part of Germany (Central-European Lowlands population). Recently, an expansion of the population towards the western parts of the present distribution range has been observed. Additionally, between 2006 and 2011, two lone wolves were recorded in Bavaria originating from the Alpine population (Bayerisches Landesamt für Umwelt 2014a). In spring 2014, two additional male wolves were identified in the Bavarian Alps (Press releases of the Bavarian State Office for Environment on 16 April 2014 and 11 July 2014).

Austria lies within the reach of several existing source populations. Dispersing individuals originating from the (Italian) Alpine, Eastern Europe and Dinaric-Balkan populations have been genetically identified in different parts of the Austrian Alps. The frequency of wolf visits to Austria increased slightly over the past 15 years, and both males and females were identified (Rauer et al. 2013). Most wolves were detected only once or a few times within a single year before disappearing again. From 2009–2014 at least 18 individuals were detected genetically. These wolves were found almost all over the country independent of the population they were originating from. Austria may therefore indeed develop into a cross-breeding area of wolves from different distinct populations (Rauer et al. 2013 and Rauer pers. comm.).

Wolf distribution in Slovenia represents the north-western part of the Dinaric-Balkan wolf population. They are distributed in south-western Slovenia (Dinaric Mountain chain), along the border with Croatia, towards the coast and in Trnovo forest in the North (Majić Skrbinešek 2013). There is only a sporadic occurrence in northern Slovenia, along the southern rim of the Alps. In Slovenia (whole country), in 2010, a genetic CMR method estimated the maximum number of wolves of 43 individuals. The minimum estimate in May 2011, after the cull and before reproduction was 32 wolves (Majić Skrbinešek 2013).

3.3 Diet and predation of wolf

The wolf is very adaptable in its diet, which is “*as broad as its geographic range*” (Peterson & Ciucci 2003). Wolves tend to live and hunt in packs. As they usually neither guard nor hide their kills, the optimum foraging strategy is to hunt prey that the hunting group can consume to the fullest extent possible in a single feeding session (Jędrzejewski et al. 2002). Numerous studies in Europe found that wolves in general preferred to prey on wild ungulates, especially cervids (Bassi et al. 2012). However, wolves quickly adapt to current conditions in regard to (seasonal) prey availability. A review of 20 studies performed in Italy between 1976 and 2004 found a general positive correlation on a national and regional level between the abundance of wild ungulates and their frequency of occurrence in the diet of wolves (Meriggi et al. 2011). A significant increase in the abundance of wild ungulates also led to a significant increase of wild ungulates in the wolves diet in the northern Apennines while livestock depredation decreased, despite an increase in the number of packs from two to four (Milanesi et al. 2012). Nonetheless, even fruit (Meriggi et al. 1991), carrion and garbage (Mech & Peterson 2003) can constitute a significant part of the diet when conventional prey is scarce. Such changes in diet occur seasonally, as the availability of prey species may change. For example, wild prey might move into more difficult and steeper terrain in summer, while at the same time domestic livestock is moved to the Alpine pastures, where it may be relatively easily accessible (Espuno 2004). Contrarily, snow conditions in winter may increase the vulnerability of wild ungulates (Nelson & Mech 1986b, Espuno 2004). The seasonal adaptation also includes preferences for different social categories within a species e.g. for juveniles (e.g. Gazzola et al. 2005), or during the rut for males as they are less attentive to their surroundings, and physically stressed (Mech & Peterson 2003, Palmegiani et al. 2013). Estimated consumption rates in Europe range from 2.8 – 5.6 kg per wolf per day (see Gazzola et al. 2007) but they may vary with pack size, season, prey availability etc. Comparing data from the western Italian Alps, the observed consumption rate is at the lower end of the range, which would translate to an annual consumption of 25 ± 8.1 red deer individuals/100 km², 39 ± 18.5 roe deer individuals / 100 km² and 11 ± 3.5 chamois individuals/100 km² (Gazzola et al. 2007).

A study on 9 packs in the French Alps between 1995 and 2009 showed a relative uniformity in their predation with 76% of wild ungulates and 8% of smaller prey (Fluhr 2011). The analysis showed that variations in the diet of the packs were based on environmental factors such as the type and abundance of wild prey and in particular the type of livestock protection programmes applied in the region (Fluhr 2011). Studies in different areas of the Piedmont Region of the Italian Alps showed that 69.5% (in summer, Regine 2008) and 90% of the total diet, respectively, consisted of wild ungulates, with the primary prey species changing almost every year between red deer, roe deer and wild boar (Marucco et al. 2010). Palmegiani et al. (2013) found that the wolf's diet in summer in Gran Paradiso National Park comprised mainly of chamois while in winter chamois and roe deer were taken in similar ratios. Outside the Alps, in eastern Germany, wild ungulates constituted over 95% of the wolf diet, with either a preference for red deer (Ansorge et al. 2006) or roe deer (Wagner et al. 2012). The degree of livestock in the diet varied considerably: almost none in eastern Germany (Ansorge et al. 2006, Wagner et al. 2012), 10% in southern Slovenia (Krofel & Kos 2010), 16% for nine packs in the French Alps (Fluhr 2011), and 31.9% in the Piedmont Region (Regine 2008). One pack in France seemed to show a preference for domestic livestock as 43% and 46% of the diet consisted of domestic livestock in summer and winter, respectively (Fluhr 2011). Among domestic livestock, sheep were the main victims, constituting 79.4% of the victims in the Piedmont Region between 1999 and 2009, followed by goats (16.8%), bovids (3.5%), equids (0.2%) and shepherd dogs (0.1%; Dalmaso et

al. 2012). In France, total numbers of domestic livestock victims have reached 8,226 for the year 2014 (DREAL 2015).

Predation impact of wolf on ungulates

A number of positive effects of wolf predation on their prey and ecosystem include the culling of unfit animals, control or limitation of prey numbers, stimulation of prey productivity and increase in food for scavengers (Mech & Peterson 2003, Peterson & Ciucci 2003). As wolves appear to take out individuals in lower physical condition, their effect on the prey population is reduced as they seem to cause mainly compensatory mortality. In central Europe, wolves selected in the winter the weakest deer with very low fat reserves (Jędrzejewski 2005 cited in Gazzola et al. 2007). Such selective culling could improve the average health of the prey population. In general, wolves have a high plasticity and use prey resources at their availability. Marucco et al. (2010) had observed almost every year a switch in the primary prey species (see above) and expected such behaviour to reduce the negative impact of predation on the prey population. Unlike lynx, wolves are also scavengers. During an intensive observation period in rather snowy winter, a pack of wolves was observed to almost exclusively scavenge on animals which have died e.g. from avalanches, without any additional hunting from the packs, showing that under conditions of high natural die-off of wild ungulates wolf may not be a source of additional mortality (Marucco et al. 2010).

Nevertheless, wolf predation on ungulate populations has led to challenges. A study on roe deer in Europe has shown that the effect of predation was higher in less productive environments (Melis et al. 2009). In the case of wolves, the annual net increase in a wild forest reindeer population of reindeer in Finland decreased from 13% to 7% due to wolf predation (Kojola et al. 2004), showing the capability of limiting at least some of its prey species populations. Human ungulate management and wolf predation can have additive effects. In Białowieża Primeval Forest, Poland, the combined effects of wolf predation and hunting have led to a decline in ungulate populations between 1991 and 1996 (Jędrzejewski et al. 2000). Modelling has shown that the profit of landowners in Scandinavia from moose hunting may be reduced by 10% or more as a result of wolf predation (Skonhoft 2006). Therefore, wolf predation should be taken into account for the management of game.

Red deer density in the eastern Alps is very high and requires special management measures to mitigate their browsing damage to forests. It can be assumed that the predation of wolves on red deer will influence this system. However, the recolonisation of wolves of the eastern Alps has just started, and there is no experience yet on the impact of wolves on abundance and distribution of red deer in such a situation.

3.4 Wild ungulates

3.4.1 Wild ungulate availability

The existence of a sufficient prey base is a key factor determining the successful return of large carnivores (Breitenmoser 1997). Populations of all wild ungulate species have been increasing over the past decades and continue to do so in many Alpine regions except for the chamois. Some countries make regular records of wild ungulate population sizes available (but often do not state census methods clearly), but others like Austria do not (Reimoser & Reimoser 2010). Hunting bag data were the only data sets almost consistently available across the Alpine Countries. Of course, data on hunting bags show clear weaknesses, e.g. not being linked with the real hunting effort invested. In Bavaria for example, hunting efforts to reduce ungulate numbers were raised

considerably over the last 20 years in order to decrease browsing impact on forest regrowth. Nevertheless, the existing data on population numbers and hunting bags were used to indicate the development of large herbivores and differences between the Alpine countries. More detailed population numbers and hunting bags are listed in the RowAlps report objective 1.¹²

Red deer have naturally recolonised the Alps, helped by reintroductions. Numbers are still increasing across the Alps according to censuses and hunting bags, with an especially strong increase of hunting bags in Austria. Hunting bags in the Alpine districts of Bavaria appear to be rising again as well, after experiencing an initial sharp drop by approx. 25% in the late 1980s followed by a slight further decrease for the next 15 years.

Roe deer are abundant and widespread across the Alps. Hunting bags appear to be still increasing in Austria and the Alpine districts of Bavaria. In the other countries they appear to be rather stable.

Wild boar hunting bag numbers are fluctuating strongly in some of the countries, with wild boar generally expanding their range and hunting bags increasing. In fact, the data compiled in the RowAlps report objective 1 show for all countries the highest hunting bags for wild boar for the most recent years.

Chamois are widespread across the Alps, but trends differ. Hunting bags in France continue to rise, while they stagnate in Bavaria and Slovenia. Meanwhile, in Switzerland and Austria, hunting bags have decreased by about a third since the early 1990s.

3.4.2. Wild ungulate management

Red deer and roe deer are the most widely distributed ungulates across Europe and the Alpine range; along with wild boar they compose the most important game species (Linnell & Zachos 2011). These populations recovered from a net decline in the 19th and 20th centuries due to widespread unregulated hunting (Putman 2011). Management practices such as regulated and selective hunting practices, increasing migratory corridors and habitat connectivity, reduction in habitat fragmentation and protection of habitat, but also reintroductions, reinforcements and artificial feeding have led to an increase and recently stabilisation of these populations. In many regions of Europe, wild ungulates are so abundant today that management practices include measures to reduce damage to crops and forests and prevention or mitigation of diseases. Hunting is the most important management practice and is used in many countries to control populations and hence limit damage to agriculture and forests (Putman 2011). Culling of wild ungulates is widespread across Europe and is largely linked to the claims of agriculture, forestry and transport sectors (Morellet et al. 2011).

In spite of these challenges, few countries have established robust long-term census system to monitor ungulate populations. Direct and indirect censuses are the most commonly used methods to monitor ungulate populations. Direct census methods may include capture-mark-recapture method (Switzerland), open hill counts (Switzerland), animal vocalisations (Italy), spot lighting (Italy, Switzerland) and drive counts (Italy, Switzerland) (Morellet et al. 2011). Estimates from indirect methods use faecal samples, animal vital rates (France), snow tracking (Switzerland) and habitat quality (France, Slovenia) among several other sampling methods (Morellet et al. 2011).

¹² Breitenmoser et al. 2015. The recovery of wolf *Canis lupus* and lynx *Lynx lynx* in the Alps: Biological and ecological parameters and wildlife management systems. RowAlps Report Objective 1. KORA, Muri bei Bern, Switzerland. 276 pp.

Wildlife in the Alpine countries is managed through legal and practical means such as protective laws and selective hunting. Legislation operates at different levels (national, regional, provincial, etc.) across Europe. One generality however, exists across European countries: game does generally not belong to the land owner (Putman 2011). Game belongs to everyone or no one – *res communis* or *res nullius*. In the case of *res communis*, the state can either sell hunting licenses or allocate the sale of hunting licenses to individuals or hunting groups and do not involve landowners in this aspect (e.g. Italy, Slovenia¹³, Switzerland). In the case of *res nullius*, hunting rights belong to the landowner who allocates licenses while the state has the right to determine management goals (e.g. Austria, Germany, France; Putman 2011).

Although hunting seasons in European countries should ideally be determined based on the ecology and natural history of the species that are hunted, it is currently not the case in several countries (Apollonio et al. 2011). Factors that should ideally be taken into account when determining a hunting season include the period of rut, pre-parturition and post-parturition. These are important factors as hunting during these key moments can disrupt reproduction and have a negative impact on the population. Hunting during periods of late pregnancy can also be negatively perceived by the non-hunters with regard to ethical concerns. Culling adult females with young can result in the death or loss of fitness of young animals still dependant on their mothers. Many European countries allow the hunting of animals during these three critical periods during the breeding season for species such as red deer, roe deer, chamois and wild boar (Apollonio et al. 2011).

Table 3: Comparison of management systems across the Alpine countries (adapted from Putman 2011), showing strong state controlled management practices on the left and individual landowner management types on the right.

	Impose/determined by state (National or regional authorities)	Proposed by land owners associations/ Hunters' associations, approved by State	Proposed by landowners associations/ Hunters' associations or equivalent voluntary (not approved by State?)
Game management district/group	Switzerland, Slovenia, France, Austria	Germany, Italy	
Management objectives	Switzerland, Slovenia, France, Austria	Germany, Italy, Austria	
Management Plan	Switzerland, Slovenia, France	Germany, Italy, Austria	
Quota/Cull Targets	Switzerland, Slovenia, France Cull carried out by game wardens	Germany, Italy, Austria Individual licenses allocated (per animal)	Global quota allocated to leaseholders
Global Quota/ Individual licenses	Cull carried out by State hunters Switzerland (Canton of Geneva), France	Individual licenses allocated (per animal) Switzerland, France	Global Quota allocated to leaseholders Slovenia, Germany, Italy, Austria

¹³ In Slovenia, the state is the legal owner of game according to the Environmental Protection Act of 2004.

3.5 Livestock husbandry

Sheep are the most important and most abundant domestic victims of predators in the Alps (Kaczensky 1996). Therefore the chapter focuses not exclusively but very much on summered sheep.

3.5.1 Development of livestock husbandry and pastoral systems in the Alps

Livestock husbandry has largely influenced Alpine societies and traditions. After a peak in the 19th century, the agricultural crisis as a consequence of industrialisation, led to the abandonment of many Alpine pastures. Contemporarily the first attempts were made to regulate forestry. Industrialisation drew people away from remote areas.

In the past 150 years, livestock populations have seen considerable changes. Cattle experienced an increase, but also a concentration; more cattle are in fewer hands than 150 years ago. Horses have been replaced by tractors and trucks. The importance of sheep, who are the main victims of large carnivore attacks, declined around 1830, when the domestic wool production lost its competitiveness to wool from abroad and cotton. Sheep husbandry is today promoted to prevent that remote pastures in the Alps are grown over by forest. Finally, goats have today totally lost their former economic significance in the mountains.

Since the middle of the 20th Century the tendency of woodland to expand and of wild ungulate populations to grow was true for the entire Alps, though with many regional differences. After the Second World War the rationalization of agriculture led again to the reduction of summered livestock and a decrease in farmers. Only the financial support in the frame of subsidies (since the 1980s) attenuated the trend and the variability of summered livestock. Nevertheless the species of livestock can still change (e.g. sheep instead of cattle or horses, sheep instead of goats and so on; Ringler 2009).

In the past 100 years numbers of summered sheep and goats have significantly decreased in the northern parts of the Alps (A: decrease to 1/7 of the numbers between 1927 to 2008; D: decrease to ½ of the numbers between 1950 to 2003; FL: decrease to 1/8 of the numbers between 1977 to 2003) whereas in Switzerland and in Italy summered sheep and goat numbers decreased only slightly (around 15%) and increased heavily in Slovenia (up to 4 times the number between 1923 to 2003) and France (additional 43%; Ringler 2009).

Important trends have influenced today's pastoral system (Ringler 2009):

- Whereas on the northern side of the Alps summered livestock clearly decreases since the 2000s, the summered livestock as well as the number and surface of used mountain pastures increases on the southern side of the Alps.
- Increasing availability of "external livestock", that is summered on mountain pastures. The share of "pension animals" increased in the 1980-1990s (e.g. in the National Park of the Pyrenees by 21%) whereas the share of "own sheep decreased (e.g. 34% in the National Park of the Pyrenees). The similar trend can be observed with cattle.
- The altitude of the "belt of alpine pastures" has been displaced significantly downwards on the northern side of the Alps since the 1970s.
- Forest surfaces increase all over the Alps since the middle of the 20th Century.
- The summered sheep number (compared with cattle) has increased in general (sheep are less time intensive as cattle), because personnel and time to take care of the mountain pastures and the summered livestock decreased.

- A further important change is the local public infrastructure (streets, a.s.o.), which allow to deliver livestock individually and leads to fluctuations of number of animals on the mountain pastures during each season. Roads allow also to be not constantly on the pasture, but to survey livestock on mountain pastures while being hosted in the valley.
- Education of personnel and main tasks on pastures has changed (more work hours for touristic services, more and more “enthusiasts” instead of full time farmers, less and less milk – processing, maintenance and care for the pastures as well as diminishing numbers of personnel on the pastures in general).
- In the absence of large predators, livestock protection measures have been largely abandoned over the past century and need to be reintroduced again. The most effective methods include livestock protection dogs, electric fences (depending on topography) and shepherds (Gehring et al. 2010).
- More and more rent agreements for the pastures.

3.5.2 Mountain pastures and pastoral systems today

Pastoral systems and practices vary depending on the country, traditions and type of terrain. There are three main types of mobile sheep herding: nomadic, transhumance (i.e. seasonal change of grazing areas) and the alp system.

Today, between 5 and 50% of the Alpine area are pastures, depending on regions. The entire surface of the Alps is around 190'000 km² (PSAC 2010). A large part of it is outside of pure pasture land, but rather in wood pastures and uncultivated areas high in the mountains. The pastures and pasturing system are important for agriculture in terms of “forage” for livestock, and at the same time for “Alpine” culture, landscape and against natural hazards. In absolute figures the surface of alpine pastures is the highest in France (more than 2 million ha), the number of pastures however is the highest in Austria (more than 13'000). Regions with an especially high share of mountain pastures related to the entire alpine area are the Oberallgäu/Bavaria/D, Provence-Cote d’Azur/F and Piedmont/I with nearly 70% as well as Grisons/CH (55%), Valais/CH (40%), Vorarlberg/A (49%), Tyrol/A (44%), Salzburg/A (42%) and South Tyrol/I (34%).¹⁴

On each alp other responsible bodies, managers and partners are engaged and make the mountain pasturing and pastoral system in the Alps a diversified and complex system. Where one alp adjoins directly the other the density of husbandries is high; especially in the western Oberallgäu and the Bregenzer Wald – around 0,7 alps/km² mountain area, but also in the Cantons of Schwyz, Fribourg, Waadtland and the Kitzbüheler Alps in Tyrol and some areas in the south-western Alps (Ringler 2009).

In Austria the contribution of alps for national economics, landscape and tourism is relevant. It is also the country with the highest numbers of „Bio-alps“. The intensification of alps for milk cows has lead to more infrastructures whereas alps where no milkprocessing occurs are extensified more and more.

In Germany the touristic use of alps is comparably smaller, and the alps are used dominantly for young cattle. A large share of the alps is managed on the base of property rights. In Germany the summer pastures have been cleared from forest and are kept very clean from bushes.

¹⁴ Almen und Alpen; Höhenkulturlandschaft der Alpen, Ökologie, Nutzung, Perspektiven“ from Alfred Ringler, Verein zum Schutz der Bergwelt e.V. 2009, S. 460

In Italy agrotourism is fostered very much as well as the numbers of summered livestock. Pasturing in forests plays still a big role and the number of possible summered livestock is determined by the forest administration.

Liechtenstein's alps are used quite intensively and tourism plays a strong role in the entire alpine area.

In Slovenia a lot of summer pastures have been afforested during the past years. The surface of summer pastures has diminished and the remaining surfaces have been intensified. Slovenia has today the highest share of forests of all Alpine countries. On the alpine pastures large Alpine villages with many small huts exist, which are largely used also for tourism.

In northern Switzerland the alps are managed in a traditional way, but based on a maximum of rentability. Mainly on high-lying pastures sheep replace cattle more and more.

Extensive pastures¹⁵ of the Alps are supported with more than 1 billion € annually. 800 million € of these are spent for alpine pastures¹⁶. The intensity of subsidies per ha for mountain pastures is different for each country and lied 2002 between 200 and 700 €/ha. Whereas the lowest amount is in Austria the highest is in Germany.

Subsidies are more and more justified by reasons of ecological and landscape ameliorations.

3.5.3 Present figures and distribution of livestock

Presently ca. 2 million cattle and 1.5 million sheep are distributed on Alpine pastures across the Alps. The trend in livestock husbandry varies, with intensification in some regions and decreasing in others, depending on local conditions. Cattle are still the most abundant livestock species summered in the Alps, but sheep are the most abundant in remote areas. Sheep are often an alternative to cattle for farmers with less time and personnel.

The decrease in milk price has led locally to abandonment of farming or switching from cattle to sheep, especially when the younger generation has to take over the farm. Many of the Alpine meadows are too remote, too steep or too small to hold cattle.

The differences between numbers of animals and the species in the Alpine regions are high.

Around ¾ of summered cattle are held in the Bavarian, Austrian and Swiss Alps, but more than 50% of the alpine sheep are in the French Alps. Sheep pastures are generally dominant in the southwestern Alps and are generally stronger in the western Alps, than in the eastern Alps. Mixed regions with sheep and cattle are widespread in the Isere, Alpes Maritimes, Piedmont, Valais, Slovenia, Werdenfelser Land and parts of Tyrol. The regions in Upper Austria and Bavaria are currently the regions with the fewest sheep in the Alps. Goats play still a role in Haute Savoie, Grisons, Ticino, in the Fribourgian Alps and finally around the Upper Italian lakes.

¹⁵ Extensive pasture is understood as: little work and capital, cheap infrastructure, small amount or no fertilization, low density of animals, robust livestock species, structured pastures with shrubs, continuous grazing, maintenance of biodiversity, independent of altitude.

¹⁶ Alpine pastures are defined as remote pastures far away from the main farm cultivated in order to be used for agriculture (extension of base for fodder, relieve of work burden of farmers during summer time in the valleys and increase of animal health and agricultural products) as well as for tourism.

3.5.4 Livestock protection measures

With the disappearance of large carnivores from their historical range, the traditional livestock protection methods were also abandoned. It was a common practice in the past, when predators were rare, to leave large herds of livestock unattended in the mountain pastures, in countries like France, Switzerland and the Alpine region of Slovenia. However, the return of large carnivores, in particular wolves requires a return to traditional pastoral ways and guarding which can be an expensive option. In most Alpine countries, the greatest number of attacks occurred during the summer season when livestock graze on alpine pastures (Anonymous 2010). The most effective protective measures against predation include guardian dogs, electric fences and the presence of a shepherd.

In order to implement effective protection measures against large carnivores, the current livestock management system is of major importance. It is e.g. easier to implement protection measures if personnel is available on pastures, if the pastures are furnished with infrastructure for shepherds, if flocks or herds are rather large and held together on a specific surface area (facilitates the integration of livestock guardian dogs).

Current monetary measures

A compensation system to reimburse for losses of livestock to large carnivores has been adopted in France, Italy, Switzerland, Germany, Austria and Slovenia. The compensation techniques vary in the different countries depending on the socio-economic status of the country as well as culture and traditional practices (Boitani et al. 2010). In the Alpine countries, most of the compensations are monetary in nature. Except for the case of some provinces in Austria, this compensation is part of a pre-arranged government programme. These programmes include the examination of the dead domestic animal and determination of cause of death by an expert. The “typical” case of lynx depredation is rather easy to identify, whereas it is more difficult to distinguish between attacks of wolves or of stray dogs (Molinari et al. 2000, Fico et al. 2005). If confirmed that the animal was attacked and killed by a lynx or a wolf, the farmer or livestock owner is entitled to a predetermined sum of money which is generally based on the breed and age of the animal. In some countries, the amount of money reimbursed is also based on the proper implementation of anti-predator methods such as livestock guardian dogs, electric fences, night-time enclosures, presence of shepherds etc.

The rationale for the compensation is that the legal protection and the recovery of the large carnivores are a societal desire, and that therefore society (hence the state) should pay for losses of those who economically suffer from the return of these animals. However, reimbursement of losses alone is an inadequate measure to solve the conflict. All countries, except Austria, support the implementation of protective measures.

Current management measures

Due to different situations in pastoral systems, livestock species as well as numbers are a result of different values of livestock summering, the kind and surface of alpine pastures in each country. Livestock protection against large carnivores has to be organized adapted to the correspondent situation. It may also mean that agricultural practices and subsidies have to be adjusted.

The intensity of care of livestock on summer pastures in the Alps is very different. France e.g. is the country with the highest numbers of summered sheep in the Alps (more than 50% of all the sheep in the Alps), however a high share of the flocks are not constantly cared for, but surveyed regularly

from the valleys. There are still a high number of personnel working on Italian alpine pastures, but only a moderate infrastructure exists.

In the German Alps, sheep predominantly are free-ranging, where they are controlled between 3 times a week to 3 times a month. Around 50% of the alps are still constantly taken care of mainly by young people from abroad and many women. The most laborious task on the Alps is still the maintenance of enclosures, whereas other chores such as taking care of infrastructure and pastures are minimized continuously. Nevertheless enclosures are mainly used in the valley. Since 2012, a special fund has been established in Bavaria for pilot projects concerning livestock protection measures, e.g. integration of guardian dogs. However, interest of livestock farmers is still low especially in the Alpine region.

In the Swiss Alps the flocks are rather small and managed extensively without permanent supervision. In the Swiss Alps only 9% of sheep breeders use a permanent shepherd. This corresponds to 30% of summered sheep that are guarded. In Switzerland, the Federal Office for the Environment (FOEN) has established and finances a national livestock protection programme, which is coordinated by the national agricultural consultancy Agridea. In collaboration with the cantons, the programme advises and financially supports farmers to implement measures to prevent livestock damages caused by large carnivores, e.g. integration of livestock guardian dogs, fences, pasture management. In addition, the programme provides advice and financial support to the husbandry, breeding and use of livestock guardian dogs.

In Austria around 600 sheep breeders own more than 100 sheep each. The median flock size is 26 sheep and 7 goats. In June, animals are summered on the Alpine pastures where they are checked once a week or two. Most of the alpine pastures are managed today from the homestead in the valley.

In Austria and Switzerland on average around 1-2 persons per Alp are still engaged continuously – mainly for Alps where milk-cows are summered. The personnel is to a large extent people from towns and abroad. Furthermore in Switzerland, occasionally nature protection projects, school classes and youth groups are involved in care for the summer pastures.

Current prevention and compensation of predation of wolf on livestock per country

The most intensive efforts for livestock protection have been undertaken in the French Alps, where the pressure of the wolf is high and the conflicts very tapered. The attacks began in 1993 and increased steadily until 2005. In 2006, the number of attacks reduced possibly due to the use of protection methods. However, the number of victims per year in 2010 was again higher than in 2005 and has approximately doubled until 2014 (Duriez et al. 2010, DREAL & DRAAF Rhône-Alpes 2011, ONCFS 2014a, DREAL 2015). On average 10 to 15% of flocks in the wolf range are attacked each year. Of those attacked, 70% of the flocks are attacked only once, while only less than 10% are repeatedly attacked more than five times (up to 20–30 times). After each attack, whether by lynx, wolf or dog/other, a damage assessment is carried out if possible within the first 48 hours of the attack (DREAL 2014b). The characteristics of the attack, state of the victim are recorded and the cause of attack are determined. In France, compensations are paid for three cases: direct losses, animals missing and indirect losses (DREAL 2014a). The compensations paid for wolf damage in all of France increased from 0.79 million € in 2008 to 2.3 million € in 2014 (DREAL 2014a, DREAL 2015).

Meanwhile, on national and regional level different wolf-groups are working („comité scientifique national du loup“, „comité national du loup“, „comités départementaux de concertation et de suivi du loup“).

The possible coexistence of sheep breeding and wolf packs has been supported by the „action pour la préservation du pastoralisme et du loup dans l’arc alpin«. Main issues are the following points:

1. The state admits to support and preserve sheep breeding and summering of sheep on alpine pastures
2. The wolf shall be preserved in the alpine area, not beyond
3. Differentiation in zones where the wolf protection has first priority and zones of “management” (“gestion”). In the zones, where wolf protection has first priority, alternative livestock protection measures and pastoral systems, which allow for wolf existence are developed and tested (mainly in the Mercantour national park and Queyras nature parc). Here the investments in time and funds are high. In the “Territoires de gestion” the control and protection against wolf population is financed by LIFE projects.

In other mountain regions of Europe the coexistence of sheep and wolf is based on the following preconditions:

- Livestock is under control of shepherds and never without observation. The surveillance is partly supplemented with donkeys (make noise, bite and knock);
- the herds are accompanied by several experienced livestock guardian dogs (Dog of the mountain of the Pyrenees, Maremmen dog, Bernhardiner, Podhalansky or Curac);
- fencing during nights (the dogs sleep near but outside of the fence);
- the flocks have to be enough big in order to engage a shepherd and livestock guardian dogs;
- adequate and quick compensation of damages caused by wolf;
- culling of single wolves that cause unacceptable damages (Ciucci & Boitani 1995, Carpathian Large Carnivore project of the WWF Munich/C. Promberger).

These measures allow minimizing attacks of wolf and bear, whereas the lynx has no chance to depredate livestock anymore.

Between 2009 and 2011, there were 15-70 cases of livestock damage in Austria. Compensations are only paid when livestock mortality is confirmed to have been caused by predators, however actual amounts paid are not available. These payments are “voluntary” as there is no legal right to compensation, and in most provinces they are covered by the hunting insurance of hunting associations.

Wolf-livestock conflict in Bavaria is currently low compared to other European countries presumably due to the low wolf presence in the region (Wölfl, pers. comm.). In 2010 when a single wolf was resident year round, 26 sheep were compensated with the amount of 3.670 €. Nowadays, within a special fund some pilot actions testing prevention measures are implemented across the country, e.g. adequate fencing and the proper use of guarding dogs.

In 2011 in Italy, there were 383 cases of livestock damage mostly on sheep and goat in Piedmont. Wolf attacks on domestic livestock were found to be significantly higher during the months of May to October (Fico et al. 1993, Gazzola et al. 2005). During these months, livestock can be found in Alpine meadows and may receive little or no protective measures to reduce the possibility of attacks by predators (Fico et al. 1993). Livestock owners are compensated for all injuries and damages to livestock by both wolf and dog unless in cases where the dog can be located and the attack positively

identified. In the Piedmont region, the total cost of direct losses was 68,000 € in 2010 and 72,953 € in 2011. An additional 19,703 € were spent for indirect losses (Dalmasso et al. 2012, Boitani & Marucco 2013).

Damages caused by wolf have started to occur in the Slovenian Alps in 2006 and are thought to be possibly caused by a single wolf. Up to 26 animals are killed per year and annual damage compensations amount up to 3,870 € (M. Jonozovič, pers. comm.).

The return of the large carnivores puts a lot of pressure on the sheep husbandry system as it has been established over the past 50 years. Although losses to large carnivores are financially compensated and preventive measures supported, the habit of letting sheep graze free on alpine and subalpine pastures is simply no longer possible with the presence of wolves. This requires a substantial change of the husbandry system with the respective personnel and leading to financial consequences.

In the Swiss Alps, 114,000 CHF for 280 animals killed by wolves was paid in 2011, and 48,500 CHF for 135 animals in 2012 (KORA 2014). Livestock kills have to be examined by an official person (state game warden in cantons with licence hunting, designated and trained person in cantons with renting hunting system) and losses are compensated to 100% if wolves are found to be the cause of death.

In conclusion, on the alpine pastures the protection of sheep and goats to avoid predation by large carnivores is of high priority. Experiences show that sheep and goats are more vulnerable to predation by large carnivores than cattle.

3.6 Perception of interest groups and individuals regarding large carnivores

The following chapter does not differ between the large carnivores. The chapter is based on the report for objective 2 of the RowAlps project, which was developed by working group 2.

Already when talking about the spirit of WISO at the very beginning of this report, the hypothesis was, that *sustainable wildlife management can't ever be a question of purely scientific knowledge – far away from it: Sustainable wildlife management has to be an expression of a will, how to deal with our wildlife species - by taking into account, by balancing and by harmonising ecological, economical and socio-cultural interests: A decision of all stakeholders involved is required - or let's just say, a decision by society (Näscher 2009).*

Therefore an analysis of the social framework and entry points for a successful management of conflicts has been required for these management recommendations. The objectives of working group 2 of the RowAlps project were to describe tolerance mechanisms for lynx and wolf among various land-user groups, and to identify factors that influence tolerance as well as potential measures to alter these factors. To reach these objectives,

- a meta-analysis of existing social science research on large carnivores across Europe was conducted by the Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft (WSL) and
- interviews and workshops with experts in the fields of hunting, alpine farming and social science research on LC were conducted by the Technische Universität München (TUM), Chair of Forest and Environmental Policy.

Due to limited resources the approach had some limitations which mainly are:

- Due to the qualitative methods used, the interpretation of the interviews and workshop outcomes are the results: a separation of the results and an interpretation of those results are not possible as in many other scientific investigations.
- Land users were interviewed only in Bavaria and then only those from the agricultural sector, as there were no resources available to working group 2 to conduct further interviews with hunters or land-users in other Alpine countries.
- Only one of the two originally planned hunting workshops was held because of a lack of participants from the western Alps section.
- All authors live and work in Germany. Although they interviewed experts from nearly all Alpine countries, their analysis is, by their account, undoubtedly influenced by the German situation in which they were socialized.

Every actor concerned with the (re)occurrence of large carnivores has his or her own view of both the central problems and the main goals of large carnivores management.

These largely implicit framings of the problem or the issues to be addressed influence the entire management process (IRGC 2005). Three different types of problem framings were identified: The population dynamics of large carnivores, the direct interactions between large carnivores and those affected; and the social and political conflicts. All three problem framings are influenced by the individual perception of large carnivores. In reality, a conjunction of these problem frames will be the basis of all large carnivores management.

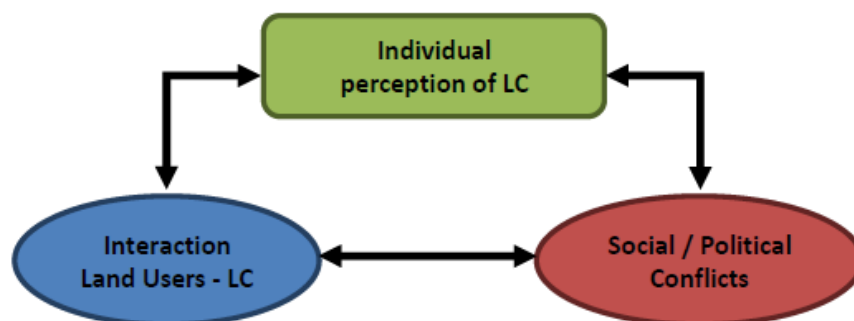


Fig. 6: Interdependencies among the various levels where factors influencing attitudes towards LC are settled.

3.6.1 Direct interaction of large carnivores and those affected

On the level of direct interaction, six main factors influencing the effect of the presence or imminent return of large carnivores on Alpine farming systems were found.

1. Financial burden / opportunity costs

Farmers evaluate the state subsidies for flock protection on two different levels. On the one hand, they want all direct expenses for flock protection covered by the state. On the other hand, the working capacity of the farmer is a restricting factor for flock protection. The farmers expect that also the opportunity costs are covered by the state.

2. Farming practices

Different types of farming practices (e.g. free ranging vs. directed grazing with the help of shepherds or fences; grazing only during summer or also in winter; herd size) require different types of flock

protection. Especially in the case of the more extensive forms of grazing, protecting flocks in the presence of large carnivores is extremely difficult in the view of many farmers.

3. Type of animals

It is well known that sheep and goats are much more vulnerable to predation from large carnivores than cattle. A special focus should be put on ancient breeds which are highly subsidized within the Common Agricultural Policy of the European Union (CAP) and also often have a high non-monetary value for the farmer.

4. Legal framework / grazing rights

Legal regulations and old grazing rights sometimes complicate both the implementation of flock protection measures and the reorganization of grazing systems.

5. Natural conditions

Natural conditions, such as the extent and density of forest, local weather conditions and topography, influence the likelihood of damage to livestock due to large carnivores.

6. Tourism

Flock protection measures using livestock guardian dogs (LGDs) might lead to conflicts with hikers and bikers, especially in regions where tourism is important.

These six influencing factors can be summarized by the concept of vulnerability. The concept of vulnerability is not meant to be a concept of zoning, but rather it is a strategy to set priorities for efforts to mitigate conflicts.

Influencing factors for the vulnerability of Alpine farming regions are the historical development, on the basis of natural and cultural conditions, current land use policies (subsidies for shepherds, subsidies for rare breeds (often sheep and goat), less subsidies for free ranging grazing (example Switzerland)) and large carnivores management (feasibility of flock protection).

Additionally, some currently practiced methods of hunting and ungulate management will be challenged by the return of large carnivores. The impact of large carnivores on both the size and the behaviour of ungulate populations must be considered in hunting and forest management planning. For example, various methods of feeding ungulates (such as efforts to influence their spatial distribution to reduce browsing effects on silvicultural crops) will be more problematic if large carnivores adapt their hunting habits to take advantage of accumulations of ungulates caused by feeding stations and winter enclosures. Adaption to the return of large carnivores may be more demanding in countries where such types of winter feeding are more common than in other countries.

3.6.2 Factors in social and political conflicts with large carnivores as a trigger for conflicts

On the social and political levels, the conflicts detected could be described as mainly power struggles and value conflicts. Here, large carnivores are often only one issue within an already existing larger conflict. The distribution of power among the various actors in such conflicts has changed in the course of the reoccurrence of large carnivores. The following conflict constellations were found:

1. Urban – rural (Power struggle and value conflict)

This conflict constellation has no clear actor structure, and is displayed within public and political discourses. Land-use actors criticize the higher degree of influence that urban actors have on political decisions. On the discourse level, a clear difference in values is constructed, in which land-use actors

are seen as having a use-orientated, anthropocentric image of nature, while the urban population are portrayed as viewing it more from an aesthetic oriented, ecocentric point of view. Also, the self-image of Alpine farmers differs from the image they have among the general public. Generally, both the general public and urban actors often criticize the negative impact of farming on the environment and the high level of subsidies. In return, farmers base the legitimacy of their practices and the subsidies they receive on their role as food suppliers.

2. Land-use actors – state (Power struggle)

The common conflicts here revolve around the subsidy system and legal regulations. Regulations that reduce the level of autonomy of land-use actors and increase the amount of control state agencies have are opposed by land-use actors.

3. Land-use actors – environmental NGOs (Power struggles and value conflicts)

The basis for the power struggle is the question of which group should have the power to make decisions about what occurs in the Alps, while the basis for the value conflict is the question of which value is more important: High levels of biodiversity and / or wilderness (environmental NGOs) or tradition and culture (land-use actors).

4. Horizontal / vertical conflicts between or within state agencies (Power struggles)

In most Alpine countries, the central conflict is a horizontal conflict between the ministries for agriculture and environment.

3.6.3 Interaction of both levels – social/political and direct interaction

The two levels of analysis are interconnected. Negative perceptions of large carnivores might result in a reduced willingness to adopt flock protection measures. An unsuccessful implementation of flock protection might increase political conflict. Political conflict influences individuals' perceptions of large carnivores and large carnivores' management. Nevertheless, we formulate the hypothesis that there is a correlation between the reason a particular actor is practicing animal husbandry and the level on which large carnivores management is or can be most successful. If the main reason for practicing animal husbandry is economical, work at the level of direct interaction between land users and large carnivores is most important. In regions where other reasons, such as tradition or cultural identity are more important, the resolution of social conflicts is crucial.

3.6.4 Management implications

The following chapter is focused on a land use perspective and mainly on agriculture. The results do not analyse nor focus on differences for single countries.

Preconditions for all paths of actions are that the social norms and values of farmers are obviously generally opposed to large carnivores:

- The extinction of large carnivores is perceived as a cultural achievement.
- Animals that are being bred are perceived as the "nature to be protected".
- Conservation of the cultural landscape is a central justification for their position. Farmers disagree with the target of establishing wilderness in the Alps, for which large carnivores are perceived as a symbol (Caluori & Hunziker 2001).

A slightly different situation concerning social norms and values of farmers can be observed in parts of Slovenia and Italy, where farmers are more familiar with large carnivores because of the relatively long tradition there of living alongside them.

Management implications in hunting

Hunters have a more ambiguous view:

- On the one hand, there is a tradition of purposeful extermination or hunting of predators. Thus, some hunters still perceive the extinction of large carnivores in the Alps that occurred in the 19th century as a good and necessary end. On the other hand, the idea of game keeping is common and could be applied to large carnivores. For example, in Slovenia hunters actively reintroduced the lynx.
- Norms that guide hunting practices are very important (Schraml 1998, Stengeli 2014). These norms can be influenced by in-group communication.
- Large carnivores have a relevance as potential trophy animals.
- Especially in Germany, the perception is common that large carnivores, particularly wolves, will not have suitable habitat in such a densely populated country (Kaczensky 2006, Stengeli 2014).

Given that the main threat to LC populations is illegal killing, in general two aspects of this problem have to be addressed:

1. Accidental killing and the
2. encounter rate between hunters and LC (and thus, the concomitant potential that an illegal killing of a LC will occur).

Furthermore, stronger control on hunters by official bodies would be necessary in order to be able to enforce protection of LC. Game wardens like the “guardacaccia” in Italy or the “Wildhüter” in Switzerland are examples of ways to implement better on-site control of hunters.

Legal regulations and financial aid (e.g. in Switzerland hunters get a reduced hunting licence fee if they can prove that large carnivores are present in their hunting area) to the hunting sector will also need to be evaluated to determine if the outcome of these steering instruments hinders the goals of large carnivores protection. Hunting regulations should be analysed if the influence of the presence of large carnivores is considered. For example, hunting quotas are often not adapted to the special challenges of large carnivores presence.

Management implications in power distribution between political actors

Managing social conflicts requires an understanding of the relationships and the distribution of power between different actors in different countries. Comparing the position and power of interest groups and actors in the Alpine countries, it seems obvious that every country has its own tradition affected by its own unique institutional setting. The return of LC and the accompanying societal discussion might cause a change in the distribution of power among the institutions involved which will also either shift the existing lines of conflict or generate new ones. The following paragraphs summarize the political actors involved, likely changes in the distribution of power between them and the main drivers of the discussion about LC are described for each Alpine country.

Austria

In Austria, private land owners, state and public forest owners and hunting associations are considered to be the most powerful players. With the return of LC, especially wolf, land owners and

hunting associations are expected to lose power, and the pressure other actors will be able to exert on them will increase. The eNGOs, the environmental authority and hunters whose main purpose in hunting is to stem the threat ungulates pose to forests will gain more influence in the field. The agricultural sector was judged as the main driver.

France

Due to the centralized political system in France, the agricultural, hunting and environmental authorities have the most power of the institutions participants identified as being involved in LC issues but also receive the most pressure from interest groups. Sheep farmers are land users, but often do not own the land they use, unlike most of their counterparts in other countries. This fact makes them a less powerful interest group in France than in other countries. With the return of the wolf to France, sheep farmers are gaining power and putting pressure on the authorities responsible for LC management. Environmental NGOs (eNGOs) have also become politically more important through their efforts to restrict traditional land-use practices (drive hunts) due to the danger they pose to the bears that are now present in the Pyrenees and hence exciting conflicts with the hunting association. The agricultural sector is perceived to be the main driver of the discussion regarding LC in France.

Germany – Bavaria

In Bavaria, private land owners and the organizations that represent them, such as the farmers' association, currently have the most power with regard to LC. Forest authorities (the forest ministry and the state forest administration) and the hunting association are struggling to influence land owners within an ongoing conflict about forest regeneration. With the return of LC, especially the wolf, both the farmers' association and the hunting association are expected to receive more pressure from eNGOs and environmental authorities. The agricultural sector was judged as the main driver of the discussion about LC.

Italy - South Tyrol

In contrast to France, land owners here are rather powerful. The "Landeshauptmann" (governor of the province) plays an equally important role as that played by the state government (Rome). Here, the hunting sector was listed as the main driver.

Slovenia

The Slovenian Forest Service (SFS) is in charge of hunting management, forest management and LC management. The fact that all of these tasks are undertaken by a single public body makes the influence of the SFS stronger than the forest agencies in the other countries investigated here. This could possibly help mitigate conflict. As a technical body that serves as a consulting entity to the Ministry for Environment and Farming, the University of Ljubljana is also perceived as a quite powerful actor that is for the most part not greatly influenced by other actors. Thus, the university has a greater influence on LC management than universities in other countries. With the return of LC, the pressure on the SFS is expected to rise, because the conflicts between land users (land owners, hunting association) and between land users and the SFS will intensify. The hunting sector was judged as the main driver of the discussion about LC, especially wolves.

Land-use practices like ungulate (game) and forest management are largely directed towards meeting economic goals. As ungulates are herbivores and browse on trees, forest regeneration is dependent on both ungulate density and forest structure (management). This implies that there are competing interests between the hunting sector (which is interested in high ungulate densities) and the forestry sector (which is interested in high levels of forest regeneration). In each of the different

Alpine countries, one or the other interest prevails depending on the relative economic importance of the respective sectors.

Management implications in farming

In the view of the experts interviewed, prerequisites for livestock breeders tolerating large carnivores are:

- functioning flock protection measures and
- sufficient funds for financial aid and compensations.

Effective flock protection demands experience with different measures under different conditions to be able to recommend the most promising method to farmers given their particular situation. Numerous open questions about the effectiveness of flock protection methods still need to be addressed.

In terms of sufficient financial aid - for example, in cases where it is not clear if damage was caused by large carnivores or other predators - solutions that involve little bureaucracy and favor land users should be established. Central here is that compensation will continue to be paid, even if compensation costs rise tremendously. Furthermore, late or reduced payments must be avoided. These are preconditions for establishing trust in and credibility for the state (agencies). In this context, processing of compensation payments through agricultural administrations is crucial. The distribution of compensation and financial aid via the established network is more promising than attempts to establish relationships between farmers and other government entities with which they have no existing relationships (e.g. environmental authorities). Farmers already have a relatively trusting relationship with agricultural authorities.

Agricultural funding must be adapted in the long term to eliminate contradictions, especially concerning the promotion of vulnerable livestock species (sheep) and inconsistencies between subsidies for extensive pasture management and flock protection measures (Meschnig 2014). In the Alps, rare breeds are often sheep or goat breeds. Thus, two biodiversity conservation goals – conservation of rare breeds vs. large carnivores protection – will have to be balanced.

Diverse synergies exist among farming methods on the one hand, which are adapted to be more suitable for a coexistence with large carnivores and pasture- and herd management methods on the other hand, that are adapted to promote biodiversity and animal welfare and are more ecologically sound.

To be able to effectively promote tolerance towards large carnivores and to find suitable solutions, the level on which conflict emerges (direct interaction or social / political) must be considered. And therefore it is crucial to be clear about the actual phase of large carnivores colonization that is taking place (as, for example, is used in Bavarian management plans; Phase 1: before return; Phase 2: occurrence of single animals; Phase 3: small population established; Phase 4: expanding population). Different phases demand different management measures, and every phase (appearance of an animal, establishment of pack etc.) must be immediately communicated to the land users.

Social conflicts are often the dominant ones, even where technical arguments are being used. A central entry point here is negotiating with the actors involved (Primm & Clark 1996; Majić et al. 2011). Preferably, this should be done before large carnivores enter a region, or at least before the first conflict occurs. Though it is tempting to adopt a “wait and see” attitude as long as there are no

conflicts, or only relatively few, management of a conflict which has already escalated is much more difficult (Glasl 2002).

Especially in countries like Slovenia and Italy that have been forced to take cost-cutting measures due to the economic crisis, the risk exists that spending little or no money early on will mean either having to spend more money later or having to deal with a major conflict.

To what extent money should be spent on managing conflicts has to be decided, and the consequences of this decision have to be borne. In France, a discussion about the amount of money spent directly or indirectly on wolves popped up.

Such questions have to be worked out among the actors involved and communicated appropriately.

Nevertheless, even early intervention and commendable handling of conflicts (financial, communicative etc.) cannot guarantee peaceful coexistence everywhere. There could be situations where it will not be possible - particularly where extensive pasture management and large carnivores (esp. wolf) must exist side by side. In those cases, appropriate courses of action will have to be defined and communicated. (See Primm & Clark (1996) for the importance of understanding and working with the policy process.)

As it is unlikely that public communication will reach land users, it is suggested developing and establishing a communication concept with land user associations as the central communicator. Affected actors should be the first to obtain new information and have the opportunity to communicate this information to their own group. An effective manner of communication will have to be worked out with the actors themselves. Role models (collection of best practice examples, farms etc. with charismatic personalities where coexistence with large carnivores works) are needed that will be perceived as in-group and, therefore, accepted in the field. These role models will have to be well-financed and scientifically assisted. For a project to be seen as in-group supported action, comprehensive involvement of actors is necessary. Examples of projects that have involved agricultural actors are the Swiss "AlpFUTUR" project¹⁷ and the Austrian shepherding and flock protection projects. In our opinion, the best mode of operation is one in which the group charged with developing measures includes the actors that must implement these measures later.

Management implications for participation and communication

It is proposed to have an increased focus on management of social and political conflicts by:

- Implementation of participatory approaches of high quality.
- Minimize goal conflicts with land use regulations (e.g. high importance of the EU Common Agricultural Policy, hunting regulations have to consider LC presence)

Finally participation is very important when dealing with management of Large Carnivores. The participatory approaches have to be of high quality (whereas the criteria of this quality have still to be identified, e.g. fitting discussions to the level of decision making, Inclusion of all relevant interest groups and state agencies). And finally a further management implication is an increased focus on in-group communication (e.g. projects in collaboration with land use actors).

¹⁷ <http://www.alpfutur.ch/index.php>

The following entry points for the social acceptance of wolf and lynx can be summarized:

1. Consideration of conflict level;
2. Negotiation with actors - for example, in participatory processes or model projects - with the goal of optimizing both flock protection and conflict management;
3. Development of a communication process with actors.

4 Discussion, interpretation and assessment of a future Alpine wolf population and main threats

4.1. Minimum viable population (MVP), ecological carrying capacity (ECC), and favourable conservation status (FCS) for the Alpine wolf population

Concepts of population viability

Per definition, a viable population size lies somewhere between the ecological carrying capacity (ECC) and the minimum viable population (MVP). The ECC is the point in an unmanaged population where the birth rate and the mortality are at equilibrium. It may be temporarily exceeded, but then the mortality will surpass the birth rate and the population will steer towards ECC again (Mills 2007). The ECC is not static but may change over time due to changes in environmental conditions and/or resource management, which influence birth rate and mortality.

The lower end of the spectrum of a viable population size is given by the MVP. However, there is more than one concept of population viability:

- *Demographic viability* calculates the probability of extinction for a population of a given size within a specified number of years as a function of natality and mortality.
- *Genetic viability* concerns the long term persistence of genetic variation and evolutionary potential, and the avoidance of genetic impoverishment through inbreeding and genetic drift.
- *Ecological viability* refers to the interaction between a species and its environment. This encompasses both the needs, but also the effects of a species regarding its environment (Linnell et al. 2008). It is more a function of the ecosystem than of the species.

Despite many uncertainties about the exact ratio between the concepts, it is agreed that it usually takes a far larger population (e.g. by a factor 10) to maintain genetic viability and/or ecological viability than for demographic viability. In general, demographic and ecological viability are assessed at the population level, and genetic viability at the metapopulation or ecosystem level (Linnell et al. 2008). However, the concept of MVP is difficult to apply: scientifically, it is not possible to correctly determine a single minimum number of individuals that will secure long term survival of the population because of the inherent uncertainty and stochasticity in nature and management; and ethically, it is questionable to manage for a minimum number of individuals (Mills 2007).

Consequently, the EU Habitats Directive does not demand MVP as a target for species, but to achieve Favourable Conservation Status (FCS). The definition in Article 1 of the Habitats Directive says:

“The conservation status will be taken as ‘favourable’ when:

- *population dynamics data on the species concerned indicate that it is maintaining itself on a long term basis as a viable component of its natural habitat, and*
- *the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and*
- *there is, and will probably continue to be, a sufficiently large habitat to maintain its population on a long-term basis” (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora).”*

The guidance document “Assessment, monitoring and reporting under article 17 of the Habitats Directive” indirectly states that a population must be at least bigger than a MVP to be able to reach FCS. The upper limit is defined by what the potential habitat can support at an “optimum density” (i.e. ECC).

FCS is based on two major Favourable Reference Values (FRV) – the Favourable Reference Range (FRR) and the Favourable Reference Population (FRP) – according to the DocHab-04-003/03 rev 3 and the guidance documents. It is stated in the guidance documents that FCS is a positive goal, where the goal should be to make species status as favourable as possible, and not just to have passed a minimum benchmark.

Like any legal text, the directive text is not based on scientific definitions. This poses major challenges in its operationalisation per se, and especially for species as diverse as lichen and lynx. An interpretation for large carnivores was made by Linnell et al. (2008) in the “Guidelines for Population Level Management Plans for Large Carnivores in Europe”.

Operational proposal to define Favourable Reference Population

“[W]e suggest that favourable reference population be defined as the sum of the following criteria:

- (1) The population must be at least as large as when the Habitats Directive came into effect, and,*
- (2) The population must be at least as large (and preferably much larger) as a MVP, as defined by the IUCN criterion E (extinction risk based on a quantitative [Population Viability Analysis] with <10% extinction risk in 100 years), or criterion D (number of mature individuals).*
- (3) The population’s status is constantly monitored using robust methodology” (Linnell et al. 2008).*

A population can be considered as viable (i.e. at least MVP) according to the IUCN Red List if it reaches at least the category “Near Threatened NT”, which is not formally a threatened category¹⁸. This category is reached under criterion D with a population of 1,000 or more mature individuals in the population. However, if the considered regional population is connected to a neighbouring population to such an extent that immigration can have a significant positive effect on the demographic viability of the population and the sum of the populations (hence the metapopulation) reaches the benchmark, then the threat category for the regional population (hence the subpopulation) can be downgraded by one level; i.e. if two connected neighbouring populations exceed the benchmark of 1,000 mature individuals, the regional subpopulation is still considered as not threatened if it exceeds the next lower benchmark of 250 mature individuals (which would classify as “Vulnerable VU” in an un-connected population; Linnell et al. 2008).

¹⁸ The ICUN Red List threatened categories are Vulnerable VU, Endangered EN, and Critically Endangered CR.

Operational proposal to define Favourable Reference Range

Put simply, the Favourable Reference Range (FRR) is the area needed to contain the Favourable Reference Population. However, the issues of habitat quality, density (e.g. societal carrying capacity) and connectivity warrant consideration.

“As a result we generally recommend that Favourable Reference Range be considered larger than the area strictly necessary to support the Favourable Reference Population, and that it attempts to ensure (1) the continuity of distribution within a given population, and (2) the possibility for connectivity between populations” (Linnell et al. 2008).

Operational definition for favourable conservation status for large carnivores

“We [...] suggest that a population can be regarded as having reached FCS if it satisfies all of the following criteria;

- (1) ‘Population dynamics data on the species concerned indicate that it is maintaining itself on a long term basis as a viable component of its natural habitat’ (Article 1 (i)). We interpret this as implying that monitoring data indicate the population has a stable or increasing trend. We believe that a slight reduction in population size may be permitted if it is a result of response to changes in prey density or habitat quality that are not the cause of direct human action, unless conditions for derogations apply [...]. All segments of a population should have stable or positive trends, and not just the population as a whole. And,*
- (2) ‘The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future’ (Article 1 (i)). We interpret this as implying that the overall distribution of the population is stable or increasing. And,*
- (3) ‘There is, and will probably continue to be, a sufficiently large habitat to maintain its population on a long-term basis’ (Article 1 (i)). We interpret this to imply that the quality and continuity of habitat should be sufficient, and have a stable or increasing trend. And,*
- (4) The population size and range are equal to or greater than when the Directive came into force. And,*
- (5) The Favourable Reference Population size has been reached. According to our proposal this will be set at levels greater than those regarded as being viable using the IUCN Red List criteria E or D. And,*
- (6) The Favourable Reference Range has been occupied. And,*
- (7) Connectivity within and between populations (at least one genetically effective migrant per generation) is being maintained or enhanced. And,*
- (8) ‘Member States shall undertake surveillance of the conservation status of the natural habitats and species referred to in Article 2 with particular regard to priority natural habitat types and priority species’ (Article 11) and ‘Member States shall establish a system to monitor the incidental capture and killing of the animals species listed in Annex IV (a)’ (Article 12.4). These statements combine to indicate that the population should be subject to a robust monitoring program.*

Criteria 1-3 and 8 are taken from the text of the Directive, criteria 4 and 6 are taken from the guidance documents, while criteria 5 and 7 are based on our own recommendations” (Linnell et al. 2008).

“[T]he absolute minimum requirements that Member States must meet are:

- (1) Countries sharing one population, or segments of a population, contribute to ensuring between them that the population reaches and maintains FCS, and*
- (2) They allow for connectivity between neighbouring populations and segments within the same population, and*
- (3) Management activities do not create a sink that can influence the FCS of a population of any of its segments, and*
- (4) Populations should in general not be allowed to go below the level they had when the Directive came into force on their territory” (Linnell et al. 2008).*

Assessment of the current Alpine wolf population

In 2009/10 there were 32 packs and a minimum of 160 wolves (not only mature individuals) counted or estimated, respectively, in the Alps (Kaczensky et al. 2013a; cf. Chapter 3.2). There is no straightforward way to estimate the number of mature individuals (MI) from either the number of packs or the number of wolves. Obviously, the minimum number of MI in this example would be 64, that is twice the number of packs (i.e. the actually reproducing wolves¹⁹). There are more mature individuals – hence potentially reproducing wolves – living in the Alps, but a qualified estimation would need further discussion and compilation of data.

The Alpine population is connected with the Italian population (the study performed by Fabbri et al. (2007) identified a continuing, moderate gene flow from the population in the Apennines to the population in the Alps, corresponding to 1.25–2.50 wolves per generation) and to the Dinaric population (as mixed couple reproduction has demonstrated) as well as to the Eastern European population (Rauer et al. 2013). The Alpine wolf population is hence not isolated, and will likely not be so in the future. Nevertheless, the Alpine population has at the moment not yet reached FCS under any of the criteria as both the population and its distribution are still very limited.

4.2 Potential distribution of the wolf in the Alps and hypothetical expansion of the population

The recolonisation of previously occupied habitat and the expansion of a recovering species of population are determined by factors such as the habitat and landscape features, land-tenure system, dispersal characteristics, resource availability and distribution, as well as human attitudes and activities (Zimmermann 2004).

Potential distribution

Four distinct wolf habitat suitability models for the entire Alpine range are so far available: the ones by Herrmann (2011) and Falcucci et al. (2013), and two distinct models by Marucco (2011). All models predict still a high amount of suitable habitat available for (re)colonisation. The model by Herrmann (2011) predicted approximately 50% of the area of the Alpine Convention as suitable habitat for wolves. Falcucci et al. (2013) predicted 5.2% of suitable area in the Alps, but we believe

¹⁹ This is clearly underestimating the number of mature individuals in a wolf population. Besides the reproducing pair, packs may include several other adult wolves or adult wolves may live independently from packs. The IUCN Red List Guidelines state that “in many taxa there is a pool of non-reproductive (e.g. suppressed) individuals that will quickly become reproductive if a mature individual dies. These individuals can be considered to be capable of reproduction” (IUCN Standards and Petitions Committee 2014).

that this is an error in the paper. Marucco (2011) adapted the spatially explicit, individual-based model (SE-IBM) developed by Marucco & McIntire (2010) and applied it to the entire Alpine range (Fig. 7). The SE-IBM includes the needs of wolf packs and the characteristics of wolf territories to predict habitat suitability of packs (Marucco 2011). Marucco (2011) presented the maps without numerical values on the amount of suitable habitat in her results.

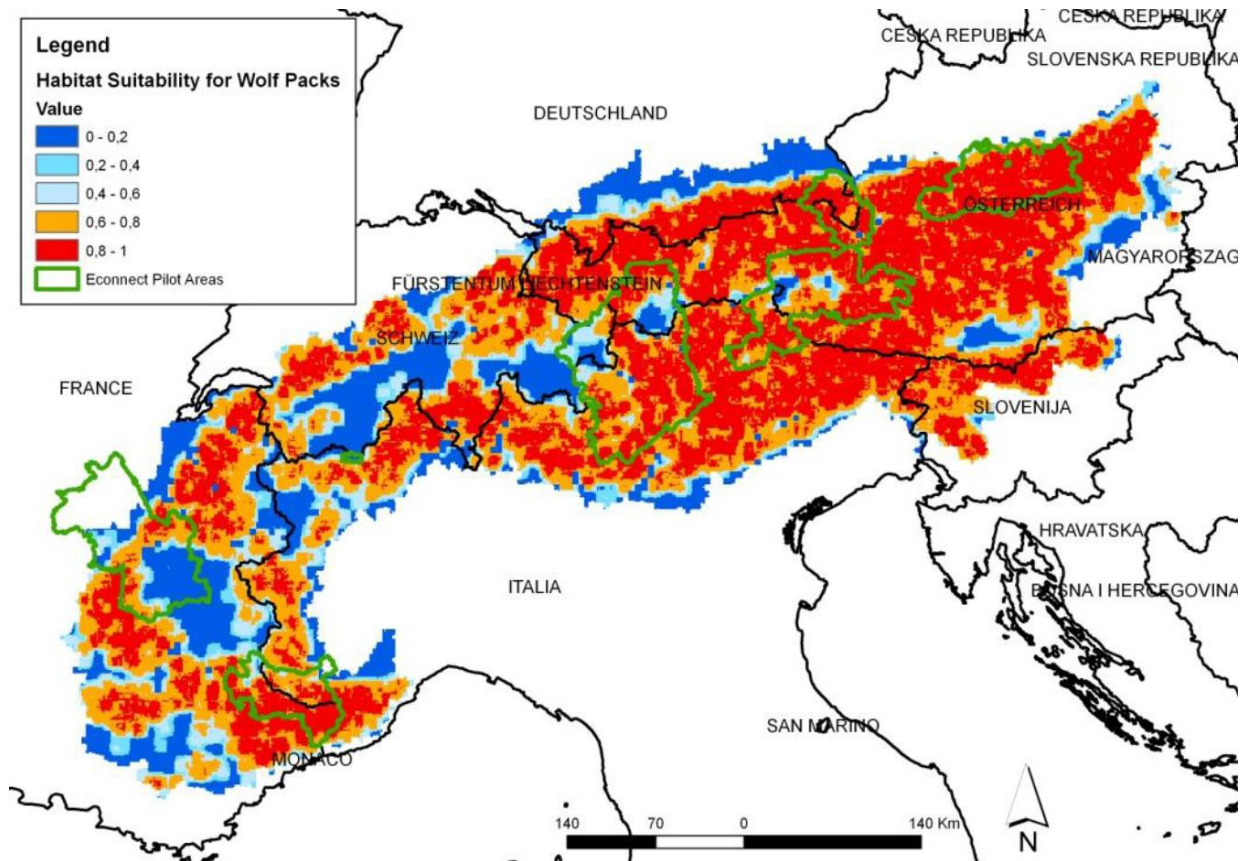


Fig. 7: Wolf pack habitat suitability map based on the spatially explicit individual-based model (SE-IBM) developed by Marucco (2011). Blue = low suitability, red = high suitability.

The results of the various (incl. regional) wolf habitat models are mainly in agreement with each other with regard to the main factors influencing wolf presence and distribution. Higher suitability is indicated in the eastern and north-eastern Alps than in the western and central-western Alps. Regions with very high elevations are generally indicated as very lowly suitable (Glenz et al. 2001, Herrmann 2011, Marucco 2011). High human density and “disturbance” (roads, settlements) were indicated to negatively impact wolf presence whereas prey abundance and diversity, and forest cover were predicted to have a positive effect (Massolo & Meriggi 1998, Herrmann 2011, Marucco 2011, Falcucci et al. 2013).

Another common conclusion of the different studies is that human-caused mortality (traffic accidents, culling, poaching) seems to be the most limiting factor for wolf occurrence and that wolf presence will likely be defined by human pressure and tolerance (Landry 1996, Massolo & Meriggi 1998, Corsi et al. 1999, Glenz et al. 2001, Fechter & Storch 2014). It was suggested that wolves can live even in areas with high road density (indicating high human presence) if they are tolerated and the population can sustain the traffic-based mortality (Landry 1997b, Fechter & Storch 2014). More

than “wilderness” it seems that wolves need sufficient prey and reduced human pressure to survive in a certain region on the long-term (Fechter & Storch 2014).

Fragmentation within the Alps (subpopulations)

No subpopulation of wolves is identified in the Alps but the wolf population in the Alps was considered to be a distinct population unit for practical reasons. High connectivity is expected for wolf habitat in the Alps. Nonetheless, high road density can result in significant mortality and reduced habitat quality through fragmentation or by providing easy access to wildlife areas to people and thus limit pack settlements. Natural and anthropogenic factors such as settlements, lakes and high rock areas can decrease connectivity (Marucco 2011).

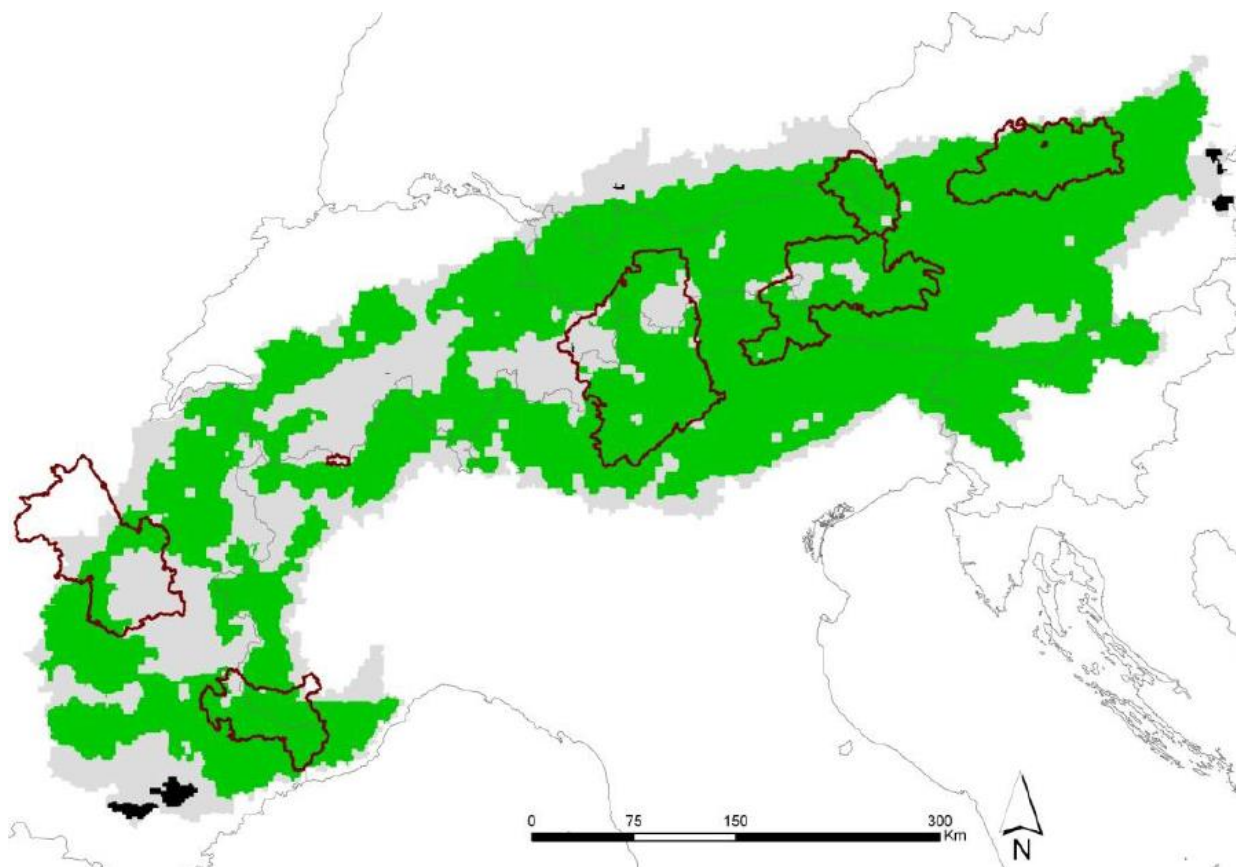


Fig. 8: Network analysis with a threshold of 0.5. Individual components of the network are illustrated with different colours against the grey background of the Alpine convention area. The sum of the coloured patches is the suitable habitat. Within a patch of a certain colour, all parts are connected. Only towards the very edges of the Alps, the network is broken, as indicated by the change in colour. Brown polygons = Econnect pilot regions (Marucco 2011).

Connectivity to neighbouring populations

The wolf population in the south-western Alps is connected to its source population in the Apennine through the Ligurian Apennine Mountains, acting as an ecological corridor also important to assure genetic exchange (Marucco 2009, Marucco & McIntire 2010, Marucco 2011). The Alpine wolf population is furthermore connected to the Dinaric population via Slovenia, as demonstrated by the genetic identification of Dinaric wolves in Austria and Italy (Marucco 2011). Wolves can also immigrate to the Alps from the Carpathian and from the Central European Lowland or north-eastern European

wolf populations, respectively, as revealed by the genetic origin of wolves found in Austria (Rauer et al. 2013), making the future Alpine population a melting pot for nowadays several genetically distinct populations.

Hypothetical expansion of the population

The wolf population in the Alps so far expanded mainly from the West to the East, with the population in the south-western Alps as the main source. Erratic colonisation is however always possible (see below). Wolf (re-) colonisation takes place in two steps: first young single individuals, mostly young males, sporadically disperse to find new suitable territories and mates. In a second step territories are established and stable reproductive packs are formed if enough suitable habitat is available (Valière et al. 2003, Fabbri et al. 2014). Several years (4–6) can pass between the first arrival of a disperser and the building of a pack (Valière et al. 2003). In the south-western Alps for example, individual wolves were first recorded in the beginning of the 1990s, and the first record of pack establishment was recorded in Italy and France after 1995 (Herrmann 2011). In Switzerland, the first wolves from the south-western Alps arrived in 1995 (Landry 1997a), but the first successful reproduction took place only in 2012 (von Arx & Manz 2013).

From 1999 to 2008 the main source for wolves, which were recolonising the Alpine range, was in the Ligurian-Maritime Alps (Marucco 2009). In the future, the main source will likely shift to the north towards the Cozie Alps region, from where the recolonisation of the eastern Alps was expected (Marucco 2009). The high dispersal capability of wolves allows for long distance dispersal and solitary wolves were already recorded in the eastern part of the Alps (Fabbri et al. 2014). However, Marucco (2009) suggested that for a recolonisation of the entire Alpine range, several wolf packs must be created in the Central Alps acting as a new source for wolf repopulation in the Eastern Alps. The establishment of a pack in eastern Switzerland (von Arx & Manz 2013), another one with parents from different source populations in the central Italian Alps (SloWolf 2012) and the first confirmed wolf reproduction in the Slovenian part of the Alps (WAG 2014) may mark the beginning of the colonisation of the Central and Eastern Alps. These events also demonstrate how erratic the establishment of new packs can be and how unpredictable the colonisation process is, especially when considering that wolves can immigrate to the Alps from several source populations.

4.3 Assessment of a future Alpine wolf population

We base the assessment of a future Alpine wolf population on the situation where the whole of the Alpine Arc is settled, i.e. the Favourable Reference Range is occupied according to Criterion 6 of the operational definition of FCS by Linnell et al. (2008; Chapter 4.1). Obviously, the crucial points in the operational definition for the future wolf population in the Alps are Criteria 5 (number of mature individuals) and 7 (connectivity within and between populations).

Potential abundance

The Alpine-wide habitat model by Herrmann (2011) predicted 92,870 km² of suitable habitat for wolf²⁰. Assuming a density of 1.3–1.7/100 km², a potential 1,200–1,580 wolves were calculated (Herrmann 2011). However, these are not only mature individuals (MI), as used for the IUCN Red List assessment. An empiric or generic formula to calculate the number of MI from the population size is

²⁰ Other publications did not quantify the extent of suitable habitat, but the maps presented seem to confirm that roughly half of the total area of the Alps can be considered wolf habitat.

not known. Another simple method to estimate the potential population is based on the current distribution. There are 15.5 packs (12 packs plus 7 transboundary ones) in the Italian Alps, covering 5,500 km² (Kaczensky et al. 2013a). This equals about 1 pack per 355 km². An extrapolation over the area of the Alpine Convention results in 538 packs in the Alps. This is, of course, an extremely crude estimate, but demonstrates that even when considering only the reproducing pairs, the MI under Criterion D of the Red List for a population to be Near Threatened (NT) could be reached. However, the population in the south-western Alps is connected to the Apennine population. Consequently, Criterion D could be applied for a not isolated population, according to which it must exceed the benchmark of 125 packs with a minimum of 250 mature individuals (when considering only the reproducing pairs as MI) to reach the FRP as defined by Linell et al. 2008; see chapter 4.1).

Connectivity within the Alps

So far, no major barriers have been identified within the Alps that would split the Alpine population into different subpopulations. Furthermore, the recolonisation of the Alps may have started in the south-west, but the packs at the Calanda, Switzerland, and the Lessinia Regional Park, Italy, have demonstrated that new packs and hence potential population nuclei can establish basically anywhere within the Alpine Arc.

Connectivity to neighbouring populations

The Alps are within the reach of wolves dispersing from the Italian, Dinaric, north-eastern European, Central European Lowlands and probably Carpathian populations. The genetic monitoring in Austria has found single dispersers from at least five different regions (incl. the western Alpine population; WAG 2014). The number of genetically effective migrants per generation is so far only known for immigrants from the Apennine population, where it exceeds the benchmark set in the Guidelines of one genetically effective migrant per generation (see above). The future will reveal the connectivity to the eastern populations. The best connectivity exists to the Dinaric population, whereas the barriers to the Carpathians and the north-eastern European populations are more prominent. However, wolves have recently demonstrated that they can disperse through human-made landscapes and overcome almost any anthropogenic barrier.

Conclusions

As the Alpine wolf population is considered to be a not isolated one a population size exceeding the minimum number of 125 packs or 250 mature individuals would be required to reach the benchmark of a FRP and thus the FCS provided that the reproductive units are more or less evenly distributed in the Alpine range.

4.4. Challenges for the recovery and conservation of the Alpine wolf population

4.4.1. Management challenges

Some challenges regarding large carnivores are specific to the management level, but may have to be adapted depending on the population development. Several management plans for wolves have suggested diversified management responses depending on the phases during the re-colonisation process.

Multitude of administrative units

While the measures may change over time with the development of the population, they should still follow the same goals and respect the same management principles in different administrative units to allow a consistent management of the entire population. The “administrative fragmentation” is a two-level challenge in the Alps. On the one hand, the suitable wolf habitat in the Alpine Arc is distributed over seven countries; on the other hand, in some of these countries (Italy, Switzerland, Austria and Germany), hunting and wildlife management is a competence of the federal states (provinces). Although all large carnivores are legally protected by national, hence higher-ranking laws, the implementation of conservation or management measures generally leads to discussions over competences, and the implementation of international agreements is hence a challenge at national level. The current lack of cooperation between nations and provinces was identified as crucial shortcomings regarding the conservation of the Alpine wolf population (Chapter 4.4.1). Improved cooperation and communication between all levels of (inter-) national administrative units is required besides the Wolf Alpine Group, which consists mostly of experts and not administrators or managers.

Guiding strategic document

With regard to wolf management, the whole area of the Alpine Convention is covered by National or Provincial Management Plans, with the exception of Liechtenstein. Nevertheless, an overarching strategic management or conservation plan for the whole of the Alpine wolf population is not yet available.

Wildlife and forest management systems

Wolves and hunters are using the same resources, wild ungulates, and some of these species like red deer are heavily managed (e.g. winter enclosures in Austria and Bavaria). Consequently, the presence and impact of the wolf needs to be integrated into the wildlife management system. As wild ungulate management is also strongly influenced by goals of and decisions regarding the forest management, foresters need to be integrated into this discussion. Considering the yet low level of experience with regard to the impact of the wolves on their wild prey species, an adaptive approach will be needed, along with intensified monitoring of wildlife populations and improved communication.

Conclusions

All major challenges of the recovery of the Alpine wolf population are anthropogenic. Tackling the socio-economic and management challenges will require both, top-down and bottom-up approaches, and will heavily rely on good communication. For example, necessary changes to long-lasting, possibly even traditional, wildlife management or livestock husbandry systems might be perceived negatively by those affected. The involvement of stakeholders in all processes should aid in preventing, or at least limiting, such a negative effect. Treves & Bruskotter (2014) emphasised the importance of always pointing out actual benefits of carnivore presence. If only the avoidance and reduction of problems and risks are addressed, social acceptance might decrease, possibly by increasing the perception of problems and risks (Treves & Bruskotter 2014).

On the positive side, financial requirements for managing conflicts with livestock owners are relatively low for national economies, although higher for wolves than for lynx. Nevertheless, even a comparatively low financial provision demands a commitment from society and political bodies. The offering of financial aids (e.g. as damage compensation) may simply be ignored in protest, if no consensus about the basic commitment can be found.

4.4.2. Most important threats and/or shortcomings

The four assessments that have been published since 2000 (Boitani 2000, Kaczensky et al. 2013a, Boitani et al. 2015, KORA 2015; compiled in Breitenmoser et al. 2015) all list human caused mortalities as one of the main threats, be it shooting, hunting, poaching, persecution, poisoning, accidental mortality, or vehicle and train collision. No other element is listed as a threat to the whole Alpine population in KORA (2015), but some further elements are listed as threats in either France, Italy or Switzerland. Boitani (2000), Kaczensky et al. (2013a), and Boitani et al. (2015) all list low acceptance and poor management structures as main threats. Additionally, Kaczensky et al. (2013a), and Boitani et al. (2015) list the deterioration of habitat due to infrastructure development as a main threat to the European population.

At the workshop from 12–13 March 2015 of the RowAlps working group 3, the major threats to the wolf and/or shortcomings were identified based on a presentation of the reports mentioned above. The low acceptance, and reasons and effects thereof (e.g. the fear of people), were evaluated to be the main threats, followed by illegal killing and various forms of conflicts with livestock management (e.g. conflicts of guardian dogs with tourism). Poor management in general was listed as a shortcoming, but more specific parts of the management were nominated as well, namely issues related to wildlife management systems/hunting systems (e.g. that the presence of LC is not taken into account for the management of wild ungulates). Too complex and sharp EU demands and policies, and a lack of cooperation between international and national administrative units were regarded to be among the main shortcomings, too. Also listed were the dangers of not taking into account people with the expanding population (i.e. information and involvement of the public), and that the consultation of interest groups is not equal to a participatory approach. These two elements are related to both categories low acceptance and poor management. Accidental mortality and the lack of knowledge were nominated, as well.

Major threats to the Alpine wolf population and shortcomings:

1. Low acceptance
2. Illegal killing
3. Livestock conflicts
4. Management issues
 - a. Poor management in general
 - b. Wildlife management systems/hunting system
 - c. Lack of practical solutions regarding EU demands and policies
 - d. Lack of cooperation between countries and/or provinces
5. Accidental mortality
6. Lack of knowledge

Hybridisation with (stray) dogs is generally considered a risk for recovering and spreading wolf populations (Boitani 2003), but as there are less stray dogs in the Alps than in other regions of Europe, the risk of hybridisation is currently not a priority issue. Nevertheless, the subject should not be neglected.

5 Practical goal

The overall practical goal is to achieve a favourable conservation status (FCS) of wolf in the Alps of at least 125 packs widely distributed across the Alps and connected to neighbouring populations. This implies especially strengthening transboundary cooperation and dialogue with local people and interest groups.

To reach FCS, a more or less even distribution of the 125 wolf packs is required across the Alpine countries according to suitable habitat.

Table 4. Minimum number of wolf packs per country to reach FCS, distributed according to suitable habitat²¹.

Country	Number of packs according to suitable habitat
France	26
Italy	39
Switzerland	17
Liechtenstein	1
Austria	39
Slovenia	3
Germany	4

The main threats to the present and future wolf population in the Alps are human caused mortalities, be it illegal killing or accidental mortality, and livestock depredation. Moreover, low acceptance and poor management structures have to be dealt with, in order to reach FCS for the wolf in the following decades.

For this purpose, the most important management issues are to secure damage prevention and compensation systems, to foster dialogue among authorities, with wildlife managers, hunters and foresters, to integrate local people in monitoring systems, to prevent and persecute illegal action through law enforcement and to control wolf-dog hybrids and stray dogs.

6 Management options and implications

Wolf conservation in the Alps needs to be actively managed. Important issues are in particular the implementation of sustainable damage prevention measures and compensation systems, addressing social and political conflicts and also the prevention of illegal action. As most of the threats and challenges are related, conservation measures must be considered jointly where appropriate.

²¹ The minimum number of packs per country were calculated from to the proportion of suitable habitat per country according to Herrmann (2011). As the calculated numbers of packs per country were a minimum, all numbers were rounded up, resulting in a sum that is slightly higher than 125.

6.1 Secure sustainable damage prevention and compensation systems for livestock damages

Damages to livestock caused by wolves can be extensive. To mitigate the negative impact of livestock depredation by wolf, the development of a sustainable damage prevention and compensation system is recommended. “Sustainable” in this case means that the measures must be longlasting and reliable even if compensation costs are rising, i.e. farmers must not fear every year whether the compensation payments are continued or not.

In most Alpine countries, the predation of wild ungulates by wolves is not considered to be a damage on which people, such as hunters, can make a claim for compensation.

Option 6.1.1: Authorities secure mechanisms for the compensation of livestock damages caused by wolf

Currently, the compensation systems vary among the Alpine countries depending on their socio-economic status as well as culture and cultural practices. In order for these already established systems to function appropriately and in the long term, authorities should secure certain implementation instruments, including the integration of compensation systems into national regulations, sufficient and sustainable funding, an impartial investigation mechanism, a network of people trained to identify wolf kills, and/or professional referees in case of doubt or disorder.

Option 6.1.1a: Authorities compensate livestock damages according to current official “lists” based on a legal obligation

Authorities that are legally obliged to compensate livestock damages should, wherever possible, adhere to official “lists” when determining the value of damaged livestock. These lists provide estimates on the market price of livestock according to species, breed, age etc., and are usually published and updated by national livestock breeding associations.

Option 6.1.1b: Authorities compensate livestock damages according to current official “lists” without any legal obligation

Even if authorities are not legally obliged to compensate livestock damages, they should, wherever possible, adhere to official “lists” when determining the value of damaged livestock. These lists provide estimates on the market price of livestock according to species, breed, age etc., and are usually published and updated by national livestock breeding associations. This option is probably less sustainable than Option 6.1.1a where authorities have a legal obligation to compensate livestock damages.

Option 6.1.2: Private institutions compensate livestock damages according to current official “lists” without legal obligation

Private institutions that have agreed or are mandated to compensate livestock damages without legal obligation, should, wherever possible, adhere to official “lists” when determining the value of damaged livestock. These lists provide estimates on the market price of livestock according to species, breed, age etc., and are usually published and updated by national livestock breeding associations. This option is probably less sustainable than Option 6.1.1b where authorities are involved in the process.

Option 6.1.3: Establish adequate damage prevention measures where livestock damages have been repeatedly confirmed

Across the Alps, livestock guardian dogs, electric fences and the presence of shepherds are considered to be adequate damage prevention measures. Such measures should be immediately implemented in areas where packs have established and damages have been repeatedly confirmed, in order to prevent habituation to livestock as an easy prey.

Option 6.1.3a: Link compensation payments to application of damage prevention measures

Authorities or private institutions that compensate livestock damages caused by wolves (with or without legal obligation; Options 6.1.1a-c) should link the payment of compensation to the prior implementation of damage prevention measures. If such requirements are put in place, they should be communicated clearly i.e. which prevention measures are regarded as adequate.

Option 6.1.4: Adapt summering systems in order to establish effective damage prevention measures

The ability to implement and also the efficiency of prevention measures greatly depends on the herding and/or pastoral systems in place. In some cases, the type of system e.g. rather small flocks (<50 animals) without permanent supervision, may even make the implementation of prevention measures virtually impossible or at least ineffective. This implies that certain systems may require adaptation. Therefore, not only agricultural practices but also subsidies that promote such systems should probably be adapted in the long term.

Option 6.1.5: Secure mechanisms for the advice on and assistance in implementing damage prevention measures by institutions in charge

To assist the farmers affected by the presence of wolf, the institutions in charge should provide advice on implementing damage prevention measures.

6.2 Foster dialogue among authorities, with wildlife managers, hunters and foresters by establishing information and consultation mechanisms for the wolf

Law enforcement, but also the implementation of conservation and management options listed above, require the support by the public and especially by interest groups concerned (e.g. land owners and land users). Several decades after the return of the wolf to the Alps have revealed that a strong legal framework alone does not guarantee the survival of the populations. Participatory processes are required. Participation, by definition, means more than just the provision of information. It is the aim to turn persons affected into persons involved, which means that compromises and common decisions must be possible. This means also that, for some issues, participatory processes are not possible. Political and legal preconditions are required which enable the possibility of reaching such compromises and common decisions. Otherwise, the process will cause frustration. However, even if a participatory process is not possible in the decision-making for a certain issue, it may e.g. still be possible for the when, where and how of the implementation. For a review of key elements of stakeholder engagement and public participation we refer to Linnell (2013). In general, the inclusion of all affected actors in decision making but specifically in the process of developing management plans is absolutely essential.

Option 6.2.1: Establish round tables and workshops to encourage dialogue among authorities and interest groups

There are conflicting goals between and within the fields of agriculture, forestry, hunting and nature protection. While the legitimacy of each of these conflicting goals cannot be discussed, the extent of the disagreement should be identified. Possible solutions are either a prioritization of the goals or a geographical identification of areas where these conflicting goals hinder large carnivore's management. An earnest dialogue addressing all critical and controversial points between the different interest groups should be started with the aim to develop common ground and find compromises with regard to wolf management and conservation. This dialogue should be facilitated by an independent and broadly accepted institution or mandated key person.

Option 6.2.1a: Establish different forms of participation in pilot regions and evaluate outcome in terms of best practice projects

There are different forms of participation processes. These vary in terms of organisation of the group, e.g. who moderates the group, the requirements of work investment for the participants of the group, the influence that the results of the group can have (participation of GO representatives from different administrative levels and agencies). For example, the analysis of one participatory process can be found in Boutros & Baumgartner (2004). The effectiveness of such variations should be tested in order to establish best practice guidelines.

Option 6.2.1b: Based on consultations with interest groups, authorities develop and implement guidelines on how to integrate wolf presence into ungulate and forest management

The experience with previous round tables and involvement of interest groups reveal that for wolf management the ungulate hunting management is crucial. Wildlife management as it has developed in the Alpine countries in the 20th century tries mainly to balance between hunting and forest harvest, hence to maintain relatively high ungulate densities while mitigating browsing damage. The impact of an efficient predator such as the wolf on the ungulate populations is a "new" and maybe considerable factor in this system and should now be taken into account in order to avoid conflicts of goals. In the field of hunting, potential ways to adapt ungulate (game) management to the presence of wolf should be discussed, for example with regard to harvest quotas and feeding practices (feeding stations, baiting, fruit trees, waste management in villages) as well as hunting practices and regulations. Furthermore, adaptation of forest management practices to reflect the carrying capacity for ungulates, and compensation schemes to address the impacts of browsing damage by ungulates due to verifiable impacts of wolf should be considered. This would require a dialogue between wildlife managers, hunters, foresters, and conservationists with the aim to adapt given wildlife management practices, especially ungulate and forest management. In addition, measures to improve ongoing internal communication and exchange between hunters regarding wolf should be integrated into wolf management plans.

Option 6.2.1c: Create suitable units for wolf, ungulate and forest management within the national borders and cross-border

As wolves need a lot of space, their management entails a different spatial scale than traditional ungulate or hunting management. Inadequate management units (e.g. for monitoring or assessment of status) often result in wrong conclusions. The Alpine countries should therefore identify and establish adequate management units for the monitoring and conservation of wolf.

Such units should consider habitat and subpopulation models, but can also be based on existing units (e.g. hunting units or national subunits).

Management units could also incorporate areas that are especially important for the return of wolf (cross-border regions, regions that adjoin core areas of wolf etc.) and areas, where the implementation of livestock protection might be more complex and/or land use practices require fundamental changes.

Option 6.2.2: Enable and foster fact-based in-group communication

Norms that guide, for example, hunting practices are very important and can be influenced by in-group communication. Therefore such in-group communication should be encouraged and also supported by providing relevant facts. The information used should come from a source which is generally accepted to be objective. A structure for the communication of such objective information should be established, too. It is even more effective, if in-group actors were involved in the gathering of the information.

Option 6.2.3: Undertake regular systematic public surveys to evaluate and refine work with interest groups and broad public ("social monitoring")

The management of any animal population should include a monitoring in order to assess the effectiveness of the management, enabling the managers to adapt the management in case of adverse results. Similarly, the effectiveness of measures to increase the social acceptance requires its own monitoring. This should be established by regular public surveys in the interest groups and the broad public.

Social-scientific aspects should be included in the monitoring process:

1. Systematic evaluation of reporting about large carnivores should be done in order to be able to reliably interpret changes in attitudes. For example, in Slovenia it was found that the behaviour of individual problem bears was responsible for a large part of negative reporting.
2. Focus groups should be created with participants from different sectors (hunting, agriculture, tourism, nature conservation) in regions with large carnivores presence in order to identify emerging problems immediately.
3. Regular systematic public surveys should be conducted, with special focus on the most relevant interest groups (hunting, agriculture, tourism, nature conservation) in order to detect changes in attitudes at early stages and to evaluate the quality of large carnivores management.

6.3 Integrate local people in the wolf monitoring

The involvement of local people increases amongst other things the feeling of involvement of more than just the person actually involved, but also of their peers. Furthermore, it may empower stakeholders through the co-generation of knowledge and make the research more robust by providing higher quality information input. It also contributes to the dialogue between the local stakeholders/interest groups and the managers/administration and can help to increase the information flow in both directions. For a review of key elements of stakeholder engagement and public participation we refer to Linnell (2013).

Options 6.3.1: Involve interested people at local level, e.g. hunters, foresters and nature enthusiasts in the monitoring of wolf

A scientific robust monitoring is the basis of all meaningful conservation and management actions. However, monitoring results should also be communicated, understood, and accepted by the local population concerned. The performance and the acceptance of monitoring, but also the general dialogue could be improved by integrating individuals from (different) interest groups into the field work, by e.g. providing specific web portals designed for the collection and assessment of observations/records of wolf individuals.

Options 6.3.2: Authorities develop an incentive system for the documented presence of wolf at regional or communal level

The presence of wolf can hamper the fulfilment of the required hunting quota or reduce the harvest of ungulate game. State institutions or land users should therefore also consider mitigating conflicts between hunters and wolf through e.g. offering (financial) incentives to hunters' associations who have wolf in their hunting grounds, if in accordance with national legislation. Such a system also offers the opportunity to integrate hunters into the wolf monitoring, e.g. by giving them the burden of onus of wolf presence.

6.4 Prevent and persecute illegal action through law enforcement

Illegal killing poses a threat wolf in Europe and can have a severe effect on the local population. However, environmental crimes are usually not a priority in law enforcement and only special cases are even noted publicly (e.g. Stadt Bern 2000²², Bayerischer Rundfunk 2015²³, ORF 2015²⁴). The following options intend to increase the awareness of the problem and of its severeness, and to improve its persecution/abatement.

Option 6.4.1: Establish or strengthen corps of independent state employed rangers and game wardens

In some Alpine countries (e.g. France, Slovenia) or in parts of these countries (e.g. Switzerland, Italy), state wildlife rangers with official status are overseeing the implementation of hunting and wildlife protection laws. Such institutions are generally better positioned to investigate or persecute wildlife crime than privately employed game wardens. An official wildlife crime corps should be established.

Option 6.4.2: Raise awareness within police, state attorneys and judges regarding illegal mortality of protected species

The law enforcement corps may not be aware of the severeness of crimes against strictly protected species, e.g. large carnivores or are generally not familiar with nature conservation regulations. Awareness of the issue should to be raised for all levels of legal intervention, from the game warden to the judge by e.g. inviting enforcement authorities to round tables (see Option 6.2.1) and offering training courses.

²² http://www.bern.ch/mediencenter/aktuell_pol_feu/2000-02-926

²³ <http://www.br.de/nachrichten/oberpfalz/inhalt/tote-luchse-bayerischer-wald-100.html>

²⁴ <http://ooe.orf.at/news/stories/2715954/>

Option 6.4.3: Secure and guarantee professional investigation methods

Investigations on illegal wildlife killing require specific professional skills. In the past, CITES and Interpol have collaborated in the organisation of courses, specific to the issue of wildlife crime. Contact with these two organisations should be made regarding the education of investigators and prosecutors.

Option 6.4.4: Enable and encourage interest groups address illegal actions

Law enforcement – especially with regard to wildlife crime – is generally only successful if it has a broad societal acceptance and is supported by specific interest groups, such as the hunters. Stakeholder groups should be informed about the severeness of the problem of illegal killing of wolf and should be invited to rigorously employ the existing legal framework and address the issue in the broad public.

6.5 Control of wolf-dog hybrids and domestic dogs

As there are fewer stray dogs in the Alps compared to other regions of Europe, the risk of hybridisation is regarded as low for the Alpine wolf population. Nevertheless, as hybridisation has been detected in neighbouring wolf populations (e.g. Apennines) this issue needs to be addressed.

In December 2014, the Standing Committee of the Berne Convention adopted a recommendation on how to address the problem of hybridisation between wolves and domestic dogs.²⁵ The following options reflect the content of this recommendation.

Option 6.5.1: Authorities control, prohibit or restrict the keeping of wolves and wolf-dog hybrids as pets

In order to prevent wolves from hybridising with domestic dogs in the first place, effective measures to minimise the numbers of free-ranging dogs, and to prohibit or restrict the keeping of wolves and wolf-dog hybrids as pets need to be put in place. National authorities should enforce any measures that control, prohibit or restrict the keeping of such animals by adapting current national laws accordingly. Furthermore, authorities need to put incentives in place that encourage the public to report any illegally kept wolves and wolf-dog hybrids.

Option 6.5.2: Authorities promote the detection of free-ranging wolf-dog hybrids by establishing effective monitoring systems

National authorities are in charge of establishing and promoting effective monitoring systems within their countries. The monitoring should focus on areas where wolf packs are more likely to be in close proximity to settlements with free-ranging dogs and/or where wolf-dog hybrids are kept as pets. Once hybridisation is suspected, experts should monitor the wolf packs more closely using genetic and/or morphological features.

²⁵ Recommendation No. 173 (2014) on hybridisation between wild grey wolves (*Canis lupus*) and domestic dogs (*Canis lupus familiaris*). Convention on the Conservation of European Wildlife and Natural Habitats. Standing Committee. 34th Meeting, Strasbourg, 2-5 December 2015.
<https://wcd.coe.int/com.instranet.InstraServlet?command=com.instranet.CmdBlobGet&InstranetImage=2654095&SecMode=1&DocId=2196762&Usage=2>

Option 6.5.3: Authorities entrust state bodies with the removal of wolf-dog hybrids

Once wolf-dog hybrids have been detected and correctly identified, individuals need to be removed immediately. The removal of wolf-dog hybrids needs to be conducted based on an official mandate, hence exclusively by state-designated bodies (at regional or national level) that have been officially entrusted by the authorities in charge. Although hybrids are included in the protection of wolves from the Berne Convention, derogations from article 9 apply to the removal of hybrids.

Option 6.5.4: Authorities establish measures to prevent wolves from being intentionally or mistakenly killed as wolf-dog hybrids (wolf-dog hybrids have the same protection status in the Bern Convention as the wolf)

In general, wolf-dog hybrids are not easily distinguished from wolves. As a consequence, wolves can be intentionally or mistakenly killed as wolf-dog hybrids. It is the task of the national authorities to establish measures in order to prevent such intentional or mistaken killings. Measures include the government-controlled removal of wolf-dog hybrids (Option 3) and granting them with the same legal status as the wolf (strictly protected according to Appendix II of the Bern Convention). Although hybrids are included in the protection of wolves from the Berne Convention, derogations from article 9 apply to the removal of hybrids.

7 Suggestions for priorities in time and space

Despite the diversity of situations that wolf management is faced with across the Alpine countries, the RowAlps project has identified a set of general management options for the entire Alpine wolf population. Although there may be some regional and national variation in the priority of implementing these management options, suggestions for pan-Alpine priorities in time and space are needed. Therefore, working group 3 of the RowAlps project identified the level and timing of priority for each of the five management options (Table 5). The report of the European Commission “Key actions for Large Carnivore populations in Europe²⁶” provided a basis for defining the level of priority and the timing of implementation for most of the options (marked with an asterisk in Table 5). The remaining ones have been assigned to a level of urgency according to the rating of working group 3. The timing of implementation was defined separately for areas with and without established wolf packs.

²⁶ Boitani, L. et al. (2015): Key actions for Large Carnivore populations in Europe. Institute of Applied Ecology (Rome, Italy). Report to DG Environment, European Commission, Bruxelles.

Table 5. Suggested level of priority and timing of implementation for management options for the Alpine wolf population.

Management option	Level of priority	Timing of implementation
Secure sustainable damage prevention and compensation systems for livestock damages (Option 6.1)	High	> Establish measures: - as soon as possible in areas with established wolf packs - upon first appearance of individual wolves in areas without established wolf packs > Continuous implementation
Foster dialogue among authorities, with wildlife managers, hunters and foresters by establishing information and consultation mechanisms regarding the wolf (Option 6.2)	High/Medium	> Establish measures: - as soon as possible in areas with established wolf packs - upon first appearance of individual wolves in areas without established wolf packs > Continuous implementation
Integrate local people into wolf monitoring (Option 6.3)	Medium	> Establish measures: - as soon as possible in areas with established wolf monitoring systems - from the onset of developing new monitoring systems > Continuous implementation
Prevent and persecute illegal action through law enforcement (Option 6.4)	High/Medium	> Establishing measures: - as soon as possible in areas with established wolf packs - upon first appearance of individual wolves in areas without established wolf packs > Continuous implementation
Control of wolf-dog hybrids and domestic dogs (Option 6.5)	Low	> Establishing measures: - as soon as possible in areas where hybridisation has been detected - where necessary in all other areas > Continuous implementation

Annex 1: Literature

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