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

2015

EUROPEAN COMMISSION
DIRECTORATE-GENERAL
ENVIRONMENT
Directorate B - Natural Capital
Unit B.3 – Nature
Head of Unit

Brussels, 03. 03. 2015
ENV B.3/MC/ug Ares (2015) 914000

Subject: Technical report

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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.

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

DECEMBER 2014

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Prepared for DG Environment, European Commission, by Istituto Ecologia Applicata, Rome under contract no. 07.0307/2013/654446/SER/B3 "Support to the European Commission's policy on large carnivores under the Habitat Directive - Phase Two", with contributions from the Large Carnivore Initiative for Europe (SSC/IUCN)

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, consistently 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.

CONTENTS

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-argumented 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 trough 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 Jope 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.

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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
Ursus arctos	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
Ursus arctos	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
Ursus arctos	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
Ursus arctos & *U. maritimus*	Canada, Manitoba*	Loud sounds and repellent chemicals	Unknown	Effective as deterrent	Not effective	-	Miller 1983
Ursus maritimus	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
Ursus americanus	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
Ursus americanus	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
Ursus americanus	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
Ursus americanus	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
Ursus americanus	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
Ursus americanus	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
Ursus americanus	USA, Alaska	Taste aversion using thiabendazol for general anthropogenic food	unknown	Not effective	Not effective	-	McCarthy & Seavoy 1994
Ursus americanus	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
Ursus thibetanus	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 MEAURES USED TO PREVENT CONFLICTS BEFORE THEY OCCUR.

CONFLICT TYPE	MAIN MEASURES FOR CONFLICT PREVENTION
Livestock depredations	- protection of livestock using electric fences and/or livestock guarding dogs - night enclosures for livestock - removal of the problem bear - transition to species less vulnerable to bear attacks
Damage on beehives, crops, orchards and other human property	- protection of property using electric fences - removal of the problem bear - aversive conditioning - removing dense vegetation (cover for bears)
Damage in forestry	- supplemental feeding
Bear occurrence near human settlements	- preventing bear access to anthropogenic food - removal of the problem bear - education of local inhabitants - aversive conditioning - removing dense vegetation (cover for bears)
Attacks on humans	- removal of bear exhibiting aggressive behaviour towards people - public education - decreasing bear habituation to humans and food conditioning (e.g. through preventing access to anthropogenic food and aversive conditioning) - use of bear spray - temporary limiting public access to most critical bear habitats and bear dens
Vehicle collisions	- appropriate planning when constructing transportation network - construction of safe under- or over-passes for bears in combination with electric fences - removing or preventing access to attractants (e.g. garbage bins) near roads and railways -measures used to prevent bear habituation to humans

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	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. 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.
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	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 advices 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	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. 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.
Management approaches for dealing with habituated and/or food conditioned bears	Except one subadult bear (only sometimes tolerant to people) detected in 1992, no habituated and/or food conditioned bears were registered in the Pyrenees. 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.
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	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. 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). 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.

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	Bavarian Bear Management plan includes following definitions: Food conditioned: linkage of human presence/houses with easily available food. Habituated: no or less shyness towards humans.
Management approaches for dealing with habituated and/or food conditioned bears	Intensive monitoring: to detect behavioural traits mentioned above Aversive conditioning: special team to apply deterrence measures Removal of animal: by special team
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	"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.
Management approaches for dealing with habituated and/or food conditioned bears	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.
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	- 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	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. 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. **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.
Management approaches for dealing with habituated and/or food conditioned bears	- 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

	- 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	- 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	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. 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.
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	Following actions are recommended in the draft of the management plan for Poland: • 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.

	• Replacement of garbage bins with bear-proof ones. • Information and education campaigns.

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	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 • 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 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: • 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 *Stephen Herrero Bear attacks. Their causes and avoidance. The Lyons Press, Revised edition 2002).* • 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 *Stephen Herrero Bear attacks. Their causes and avoidance. The Lyons Press, Revised edition 2002).*

Management approaches for dealing with habituated and/or food conditioned bears	Historical there were three approaches used: -do nothing -capture and relocate a problem bear -shooting the/a bear (not always the right one) 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. 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.
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	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 Brașov, Tușnad this was the most effective tool for human- bear conflict. 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.

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 Jonozovič
The description of the habituated and/or food conditioned bears in the official national documents	In Slovenia, two documents describe the notion "habituated and/or food conditioned bears" in a more plastic and indirect way: 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: • 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.

Management approaches for dealing with habituated and/or food conditioned bears	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: • 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. 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. 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.
Management approaches for prevention of occurrence of habituated and/or food conditioned bears	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.

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	There are no official guidelines defining habituated or food-conditioned bears in Sweden, regarding national or regional management plans or other official documents. 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.
Management approaches for dealing with habituated and/or food conditioned bears	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. 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.
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.

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.	
	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	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.

Degree of problem and urgency of action	Individual bear behaviour	Recommended management actions	Recommended public communication actions
	bear is repeatedly intruding compact residential areas	- 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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