Recommendations for situations involving wolves close to human activities

1. Introduction

In the last decades, wolves have experienced a continuous recovery in the human-dominated Europe (Chapron et al., 2014; Kaczensky et al., 2024). Excluding islands, wolves are now present in all EU Member States, occupying different human-dominated landscapes. Although wolves persisting in these landscapes avoid human infrastructures and activities (e.g., Sazatornil et al., 2016; Ronnenberg et al., 2017; Rio-Maior et al., 2019; Carricondo-Sánchez et al., 2020; Barker et al., 2023; Zanni et al., 2023) or have adapted to use some infrastructures (e.g. roads) in a cryptic way to avoid human encounters (e.g., Zimmermann et al., 2014; Llaneza et al., 2016; Dennhey et al. 2021; Smith et al. 2022); a certain degree of habituation toward humans and their activities is expected to observe in wolves under this scenario.

The recovery of wolves across Europe inevitably leads to increasing likelihoods of human-wolf encounters. Given the dispersion of human activities across the landscape and the large spatial requirements of the species (with home ranges from a few hundred square kilometers to more than a thousand square kilometers in Europe and dispersion over considerable distances, e.g., Ciucci et al., 2009; Jędrzejewski et al., 2007; Mattisson et al., 2013; Ražen et al., 2016; Silva et al., 2018; Vorel et al., 2024), it is not realistic to expect wolves entirely avoiding human settlements, infrastructures, or even people, and like other wildlife, they can be also observed during daylight hours (Kojola et al., 2016; Reinhardt et al., 2020; Martínez-Abraín et al., 2023; Ferreiro-Arias et al., 2024; Frybova et al., 2025). Wolves dispersing into more densely populated and more fragmented areas may show less avoidance of human infrastructures than before, even after their dispersal (Barry et al., 2020). Consequently, wolves can be observed sometimes in the vicinity of human settlements, although this behavior does not pose a direct threat to people.

At the same time, wolves recolonizing such landscapes may trigger concerns among people when they are seen in the vicinity of settlements or close to humans, because the perception that wolves should be shy and they are supposed to inhabit wild and remote areas (Figari & Skogen 2011; López-Bao et al., 2017). The extent to which these observations are perceived as a problem may vary across countries. In Sweden, for example, the observation of wolves near populated areas (these sightings often involve wolves approaching inhabited houses or being seen along roadsides) was interpreted as showing limited fear of humans. Such assumed lack of fear has led to increased monitoring of potential cases (Reinhardt et al., 2020; Wabakken et al., 2020). There are two types of situations in which people may be worried and motivated to report a wolf observation assuming an undesirable or threatening behaviour or risky situation (Karlsson et al., 2007); situations in which human expectations of what is normal wolf behaviour do not correspond to how wolves actually behave in a particular situation (for example, when wolves allow people to approach at close distances or are sighted near human settlements) or situations in which wolves really act in a bold manner, that is, the animal intentionally approaches humans (Frybova et al., 2025).

There are several reported cases in Europe where wolves have exhibited a strong habituation to humans or bold behavior, without attacking them (Linnell et al., 2021; Frybova et al., 2025). Although there is a lack of homogenous definitions for strong habituation and bold wolves across Europe, systematic monitoring of potential cases, and awareness and motivations to report cases, among other factors (Frybova et al., 2025), so far, available information suggest that these cases are rare events. Between 2008 and 2011, ca. 12,000 wolves were estimated to occur in Europe (Chapron et al., 2014); whereas this figure reached up to ca. 23,000 wolves in the period 2017-2022/23 (Kaczensky et al., 2024). During the similar period (2012-2022), Frybova et al. (2025) compiled 20 cases of wolves whose behaviour matched with their definitions of strongly habituated and bold wolves (1 strongly habituated, i.e. allowing people to approach, and 19 bold wolves, i.e. approaching humans; on average, 2 cases per year on average). Similarly, wolf attacks on people are very rare and they have usually been linked to the presence of rabies (e.g., in Lithuania and Russia), the absence of wild prey (e.g., in India and Iran) or wolves that had a life history with strong habituation to humans (e.g., Penteriani et al., 2016; Linnell et al., 2021; Frybova et al., 2025). In Europe, there have been attacks reported by non-rabid wolves in for example Poland (2018) and Italy (2020, 2023, 2024) (see Frybova et al., 2025 for a detailed report of attacks in Europe for the period 2012-2022). For some of these cases, suspicions that the involved wolves were raised in captivity were high (Frybova et al., 2025). From the 20 cases evaluated in Frybova et al. (2025), these authors concluded that strongly habituated and bold wolves are often the result of human actions in origin. Similarly, most cases of bold wolf behaviour reported in the literature involved wolves that were previously strongly habituated to the presence of humans (McNay 2002; Reinhardt et al., 2020; Nowak et al., 2021).

From the point of view of the real or perceived threat of wolves to human safety, habituated wolves does not necessarily pose a threat, as habituation covers a wide behavioural spectrum, ranging from natural and unproblematic behaviours to other behaviours that may lead to risky situations under some circumstances, such as in close human-wolf encounters (Baker & Timm 2017; Linnell et al., 2021). The development of a strong habituation might need to be discouraged to prevent further development into more risky behaviours (i.e., bold behaviours). For example, in the six reported cases where non-rabid wolves have bitten humans in Europe between 2002 and 2020, all the incidents were preceded by unusual behaviours from each individual repeated over time, indicating a stage of strong habituation, being frequently in close proximity to humans or relying on anthropogenic food sources (i.e., food-conditioned wolves) (Linnell et al., 2021; Nowak et al., 2021).

The increased public concern observed across Europe on the potential outcomes from close interactions between wolves and people requires a set of guidelines on how to manage situations involving strong habituated and bold wolves by authorities, in order to ensure an adequate, appropriate, and prompt management of eventually risky situations. Here, we offer a set of recommendations to form a basis for the use of interventions when managing undesirable wolf behavior in relation to humans and to make it possible to evaluate the possible effect of the interventions.

1.1 Objective of the recommendations

The purpose of the recommendations included in this document is to provide a basis for the use of interventions (from documentation of potential cases to removal of individuals if needed) when managing undesirable wolf behaviour in relation to humans, and to evaluate the possible effect of the interventions. The recommendations are based on the best available science and best practices and are intended to be a guideline to depart from when managing such situations. These recommendations do not cover situations related to attacks on livestock or dogs, even although these attacks may be also the reason why wolves approach people or inhabited houses sometimes. We fully acknowledge that there can be however borderline cases where, for example, the wolf is attracted to areas close to humans by the presence of dogs.

The proposed set of recommendations are aimed to avoid the occurrence of injured or killed people by wolves in modern Europe, and to promote that a majority of people living in wolf areas will trust authorities in the way they will deal with risky situations for people involving wolves.

Please remember the objective above when reading or discussing the recommendations given. This protocol aims at decreasing the risk of wolf attacks on humans in different situations (figure 1). It does not aim at identifying what wolf behaviour can be accepted by humans or at affecting human attitudes towards wolves. The objective will heavily influence when it is appropriate to use different interventions. It is thus important to acknowledge that a different objective than the one above will lead to different recommendations on which intervention to use and when.

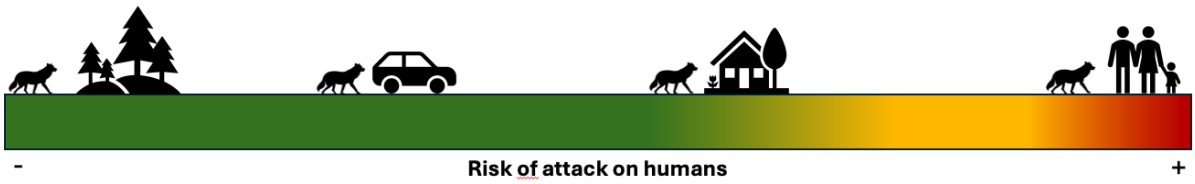

Figure 1. *Schematic illustration of categories of situations with gradually increasing risk of wolf attacks on humans*.

Given the variability of the contexts in the different European countries, the recommendations should be seen as rules of thumb indicating an appropriate way forward in most situations. They will not be applicable in all situations. There will be situations where there will be reasons to act differently than these recommendations suggest, and that is perfectly fine. Nevertheless, an important effect of this type of recommendations is that they allow decisions to be made quickly in most cases. In the more unusual cases, it is still helpful to use the recommendations as a start and then pinpoint in what way the case at hand differs and why it is necessary to act in another way than recommended in general. Recommendations are given for when and in what order different interventions should be considered. We have tried to make the recommendations detailed enough to be practically useful, but general enough to be possible to use in countries and areas with large differences

in wolf management, culture and tradition. There is thus plenty of room for interpretation and local adjustments. Examples of cases and proposed interventions are provided in an appendix. Another important function is that if a certain type of situation is handled and documented in a similar way across different countries, the outcomes can be compared to evaluate the effects of the same interventions. This will allow us to learn more about the effectiveness of interventions in a few years rather than decades.

1.2 Terminology

The terms used to describe situations in which wolves come close to humans or inhabited houses and the terms of interventions used to handle these situations are used differently by different countries, authorities and organisations. This may lead to misunderstandings and unnecessary conflicts. What is considered a normal or natural behaviour can for example vary both between different people and within the same person at different times (Barmoen et al., 2024). It is thus difficult to use the term “normal/abnormal” or “natural behaviour/unnatural behaviour” to decide whether interventions are needed or not. For example, it is both normal and natural for wolves to court dogs, scavenge on slaughter remains thrown in the outskirts of a village or to observe people motivated by curiosity. However, they are rarely a behaviour that is considered desirable, and this is why we take measures to prevent it.

Considering the intrinsic variability of behaviours and how differently they are perceived in different socio-cultural contexts (Barmoen et al., 2024), using the term *undesirable* behaviour, instead of normal or natural, is expected to make it in the long term easier to communicate about these issues. Although what is considered undesirable can also vary between different humans and times, it is easier to agree on what behaviours are undesirable and how to avoid them, than it is to agree on what is normal or natural.

In these recommendations we use the following definitions:

- **Interaction** – A situation where a wolf and human is reacting to eachothers presence. As it is often difficult to know what an animal is actually reacting to, the usefulness of the term is limited. The term is however used repeatedly in older literature that is referred in this document.

- **Habituated wolf** - A wolf that appears to not care about the presence of people and allows people to repeatedly approach at short distances without moving away (Frybova et al., 2025).

- **Bold wolf** - A wolf that repeatedly approaches people (being recognizable as people) at a short distance (30 m or less) (Frybova et al., 2025). Wolves that approach humans at a short distance once might exhibit bold behaviour but are not to be classified as bold wolves, as the reiteration of bold behaviour is key for such classification. The threshold for an encounter between wolves and humans at a short distance is set arbitrarily at 30 m. Most wolves have a much longer flight distance (Karlsson et al., 2007; Wam et al., 2014). Such a limit is in addition supported by ballistic tests and experience-based information in the use of rubber bullets for aversive conditioning (e.g., Reinhardt et al., 2020).

- **Deterrent** – An intervention that use for example aversive, harmful, fearful, or noxious stimulus to prevent undesirable wolf behaviours (Mason et al. 2001). According to Shivik et al. (2003), two main types of deterring interventions have been used, and sometimes misunderstood, in situations with large carnivores. The first type (**primary repellents**) aims to immediately disrupt what the wolf is doing and

make it move away from a particular site. The second type (**secondary repellents**) aims at making the wolf associate a certain situation with a perceived discomfort in order to reduce the likelihood of the animal ending up in the same situation or at the same location later. They rely on animal learning to become effective, by linking the secondary repellent to a particular situation (undesirable behaviour) and resulting in aversive conditioning after such a link is established between a behavior and a negative outcome (aversive stimuli; for example, rubber bullets to be associated with humans or houses). Secondary repellents can be difficult to apply in management situations, because of challenges of specifying the aversive stimuli to a particular undesirable behaviour. The differences in the conditions that need to be met between primary and secondary repellents, the measures required, and the expected results are enormous.

- **Hazing –** Implementation of a negative stimuli to immediately deter an undesirable behaviour (Schirokauer & Boyd 1998). Hazing is a primary repellent (see above).

- **Aversive conditioning** - A learning process in which deterrents are continually and consistently implemented (aversive conditioning treatment) with an animal in order to reduce the frequency of an undesirable behavior over time. The aversive stimuli is paired with a specific undesirable behavior to achieve conditioning against this behavior (Shivik & Martin 2001; Hopkins et al., 2010).

In order for terminology to be clear we need to differentiate between terms describing events with wolves close to humans/inhabited buildings, which may not be a case of habituation or bold individuals, and events where there has been a change of behaviour in the wolf/wolves (figure 2). A critical aspect is the recurrence of undesirable behaviours over time to identify cases of habituation and bold wolves. Frybova et al. (2025) observed a long average duration of cases of habituation and bold wolves (5.3 months). The observation of a single episode of bold behaviour or habituation does not necessarily mean that it is a case demanding immediate intervention but it demands an appropriate level of monitoring over time. Using terms that imply a changed wolf behaviour for all situations with wolves close to humans or inhabited houses may lead to incorrect expectations of what interventions responsible authorities should undertake. For example, if the case is related to a food-conditioned wolf, trying to change its behaviour with the use of rubber bullets once may be ineffective. However, it may seem far-fetched to propose information meetings for the residents as a way of dealing with the issue.

Based on Frybova et al. (2025) we propose the use of a terminology based on the **actual situation observed**. Reports of wolves within 30 m of an inhabited house would be assigned to the category "**wolf near human activity**" (e.g. building, vehicle or human on horseback), and reports of wolves within 30 m[1] from a person on the ground (i.e. not in a building, vehicle or on horseback) would be assigned to the category "**wolf near human**". Events being categorized as "wolf near human activities will most often not result in management interventions. Events being categorized as "wolf near human" will more often result in responsible authorities carrying out documentation and interventions. In the case of wolves

[1] The distance of 30 me is chosen from ballistics tests that report significant changes to trajectory and energy of rubber bullets shots at distances higher than 30 m.

near human, the wolf recognizes the person as a human being and deliberately chooses to approach or not to flee away. All cases of wolves near human activities and near humans include some level of habituation. At the extreme, wolves near humans include those cases of strong habituated and bold wolves. At the very extreme of the gradient of likelihood of risky situations for people, exceptionally, we would have the cases of wolf biting people without being intentionally or unintentionally provoked.

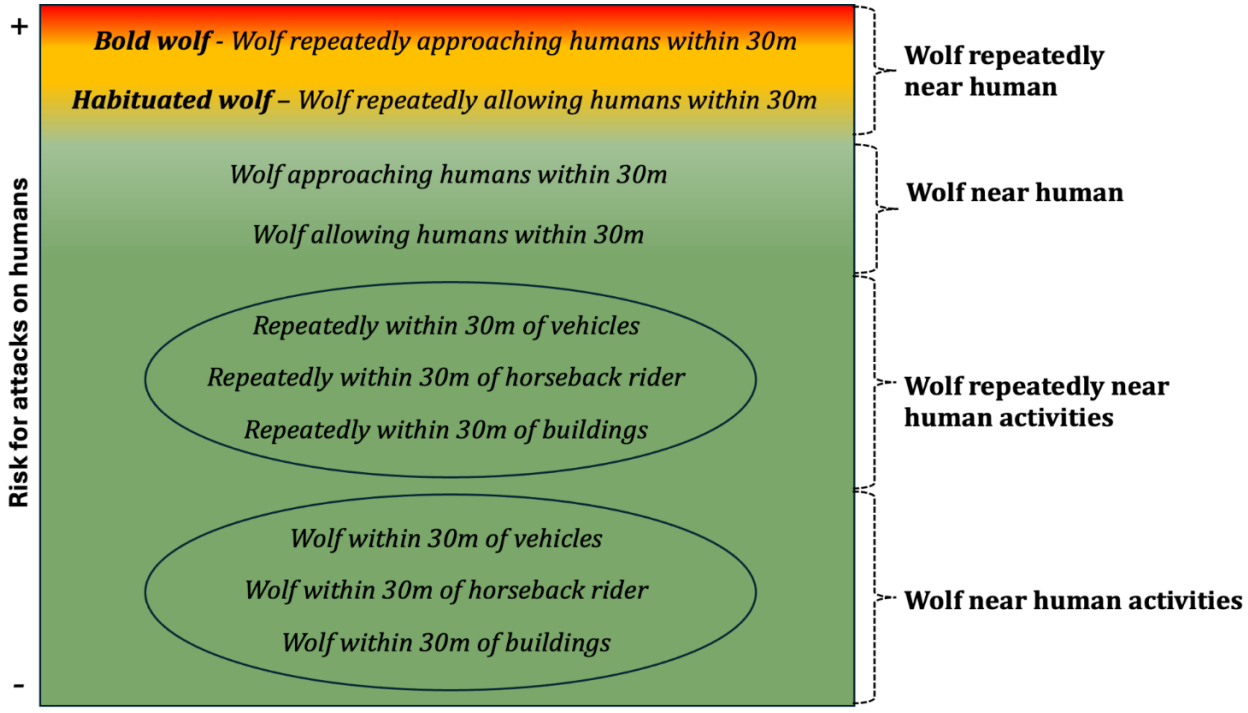

Figure 2*. Terms used when assessing the likelihood of a risky situation for people in situations meeting the criteria for wolves near human activities and humans. Risk is expected to increase with the recurrence of the undesirable behaviour.*

2. Best available science on intervention effectiveness

To reduce the likelihood of a risky situation for people by large carnivores, various interventions are available either, to modify the behavior of the animals, or the behavior of humans in the vicinity of wildlife (White & Gehrt 2009), or both. Interventions intended to temporarily alter animal behavior include, but are not limited to, more technical interventions such as visual or acoustic deterrents and barriers (e.g., Jope 1985; Herrero & Higgins 1998; Hawley et al., 2009; Appelby et al., 2017). There are also practical interventions which are intended to succeed in long-term behavioral changes, including efforts to achieve aversive conditioning or relocation of the animals (Shivik et al., 2011; Johnson et al., 2018). Interventions intended to alter the behavior of people around wildlife include information campaigns or experiential education about how to act near wildlife (e.g., McCarthy & Seavoy 1994; Sponarski et al., 2016).

For the benefit of human safety and wellbeing alongside large carnivore conservation, a sound allocation of funding, and the continuous development of best practices, it is important to collate evidence of intervention effectiveness and identify potential knowledge gaps. Previous reviews of intervention effectiveness have identified a lack of credible evidence for how to manage risky situations involving close encounters between large carnivores and people (Löe & Röskaft 2004) or insufficient evidence to draw conclusions about their effect in specifically reducing attacks on people (Khorozyan & Waltert 2019).

Based on our knowledge about the existing literature we deemed it unlikely to find much information from studies targeting wolves and thus extended the scope of the review to include evidence for effect of interventions to reduce risky situations for people from any carnivore species with a size of >15 kg. Below, we present condensed information on the findings from a systematic review of evidence for intervention effectiveness to reduce the risk or severity of direct attacks on humans by large carnivores.

The systematic review was done during 2024 and was preceded by publication of a systematic review protocol (Eklund et al., 2024). Duplicates were removed among the initial 22 097 records, followed by a manual eligibility screening of titles and abstracts of all remaining records (see Appendix I for details on the PRISMA diagram of the review process). A total of 307 potentially eligible articles were subjected to full-text reading after which **24 articles remained for inclusion in the synthesis**. The 24 articles describe 1-16 tests or studies each of interventions within three main intervention categories: **Information, Barriers, Deterrents and Removal**. We used **Risk Ratios** (also called relative risk, see Box 1) to assess the effectiveness of interventions.

It is noteworthy that most studies meeting our inclusion criteria have been carried out in North America (19 from USA, 2 from Canada, 1 North American), while Australia contributed with two studies. No studies from Europe. Most studies are related to bears (n = 14). Only very few of the interventions has been tested in relation to wolves (Figure 2).

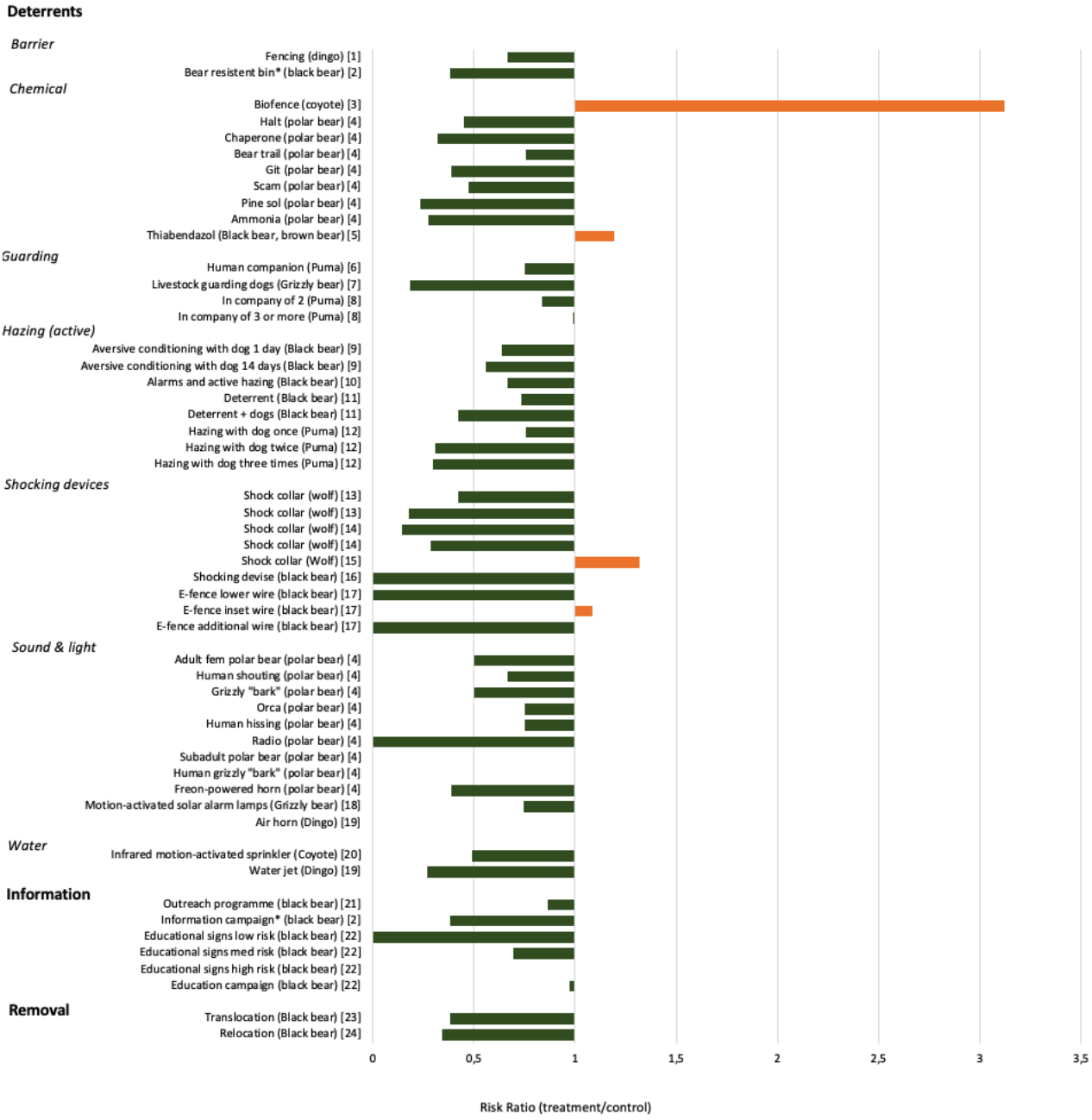

***Figure 3**. Risk ratios are calculated based on data presented in the following references: [1] DHPA (2012), [2] Johnson et al. (2018), [3] Shivik et al. (2011), [4] Miller (1987), [5] McCarthy & Seavoy (1994), [6] Wang et al. (2019), [7] Young & Sarmento (2024), [8] Coss et al. (2009), [9] Leigh & Chamberlain (2008), [10] Breck et al. (2007), [11] Beckmann et al. (2004), [12] Parsons et al. (2025), [13] Gehring et al. (2006), [14] Hawley et al. (2009), [15] Breck et al. (2006), [16] Rossler et al. (2012), [17] Otto & Roloff (2015), [18] Sarmento (2024), [19] Appelby et al. (2017), [20] McLellan & Walker (2020), [21] Gore et al. (2008), [22] Baruch-Mordo et al. (2011), [23] Weaver et al. (2023), [24] White et al. (2022). Focal carnivore species are specified in brackets.*

** the same measure in a study on the combined effect of information and barrier on bear damage.*

Box 1. Understanding Risk Ratio (RR)

Risk ratio (also called relative risk) is a way to compare how often something happens in one group versus another.

How It Works:
Imagine we are studying two groups of wolves:

- One group is exposed to shooting with rubber bullets to create aversive conditioning (Treatment).
- The other group is not exposed (Control).

We then check how many wolves in each group develop a certain behavior (like approaching humans within 30m).

What the Numbers Mean

- Risk Ratio = 1 → No difference in relative risk. Wolves approaching humans within 30m happens just as often in both groups.
- Risk Ratio > 1 → Higher risk. Wolves approaching humans within 30m happens more often in the exposed group (treatment).
    - Example: If the risk ratio is 2, wolves in the exposed group are twice as likely to approach humans within 30m.
- Risk Ratio < 1 → Lower risk. The event happens less often in the exposed group.
    - Example: If the risk ratio is 0.5, wolves in the exposed group are half as likely to approach humans within 30m (suggesting a protective effect).

2.1 Information

Communication with people when a potential case of strong habituated or bold animal has been documented aiming at:

- Informing local residents about the situation that has been documented.
- Informing about what can be done (by residents and authorities) to reduce the likelihood of a risky situation.
- Encouraging further reports to the authorities of focal animals observed in the area.

Summary of evidence on communication from the systematic review

Three studies have evaluated the effect of information to citizens to prevent attacks and damages by American black bears (*Ursus americanus*) in residential areas. One of the studies evaluated the combined effect of bear proof garbage containers and an information campaign to encourage citizens to remove bear attractants, on the occurrence of American black bear raiding of trash containers in residential areas in Colorado State, USA (Johnson et al., 2018). In this study, a reduction in the occurrence of bear raiding in trash containers was observed within treatment areas (n = 2) as compared to control areas (n = 2). A second study (Gore et al., 2008) evaluated the effect of an outreach program focusing on residential behaviours to prevent black bear damage in New York State, USA. The percentage of reported bear attacks after the outreach program was somewhat lower (27% compared to 38%) in the treatment towns (n = 2) compared to control (n = 2) towns. Finally, a third article (Baruch-Mordo et al., 2011) evaluated the effect over a 3-week period of on-site educational signs on dumpsters in communal housing complexes in Colorado State, USA. The mean probability of violating the ordinance declined among treatment housing complexes (n = 4) in comparison to the control housing complexes (n = 3) with low risk of bear damage. In treatment housing complexes (n = 10) with medium risk of bear damage the probability of violation of the ordinance also declined after the educational signs in comparison to control housing complexes (n = 12). The effect of the educational signs on the probability of ordinance violation in treatment housing complexes (n = 20) in comparison to control housing complexes (n = 19) with high risk of bear damage, no additional effect of the information was observed. Within the same article, the authors also evaluated the effect of an educational campaign (Bear-Aware) on compliance to use bear proof garbage containers during a 6 - 8 weeks period. The probability of campaign violation did not differ in the treatment of residential areas (n = 2) in comparison to residential areas which had not received the campaign (n = 2).

2.2 Barriers

Summary of evidence on the use of barriers from the systematic review

Two articles described the effect of barriers to prevent human-carnivore interactions. The first study, published in a report from the Department of Environment and Heritage Protection in Australia (DHPA, 2012), described the use of fencing to prevent dingoes (*Canis*

lupus dingo) from entering a high-use visitor area in Fraser Island, Australia. The risk of human-dingo interaction was reduced in the treatment area (n = 1) during the 12 months after fence installation, compared to incident rates outside of the fenced area (n = 1). The second study evaluated the combined effect of bear-proof garbage containers and an information campaign, and its findings are reported in the subsection for information interventions (Johnson et al., 2018).

2.3 Deterrents

2.3.1 Primary repellents

One of the oldest interventions, and an example of a primary repellent, is a scarecrow. A scarecrow can be almost anything that an animal is not expecting to be in that specific location, such as a person, flashing lights or large objects. These objects can sometimes prevent carnivores from moving to the site, at least for a short time. Animals become habituated to fixed objects quickly (Shivik et al., 2003). If the objects are moved around randomly between days or are moving, the effect may be prolonged (Shivik & Martin 2001). Sound can also frighten or alarm a carnivore (Blackshaw et al., 1990; Bombford & O'Brien 1990; Koehler et al., 1990). Radios, ultrasonic devices and other noises played may have the same time-limited effect as various types of visual deterrents. The advantage of all these types of devices is that they are simple and can be used by anyone who feels the need. The expected effect is that the animal will not come to the area as long as the scaring device is present, and it has not become accustomed to it.

Summary of evidence on the use of sound and light deterrents from the systematic review

One article (Miller 1987) presents multiple field tests of sound deterrents to prevent polar bears (*Ursus maritimus*) from accessing bait sites (8 tests) and approaching the researchers (1 test) in Manitoba, Canada. In comparison to untreated bait sites (n = 14), the study observed a reduced access to treatment bait sites with sound of a female polar bear (n = 16), human shouting (n = 9), a barking grizzly bear (n = 4), killer whale sounds (n = 4), a human imitation of polar bear hissing (n = 4), and random radio noise (n = 2). There was no observed effect, however, from playing the sound of a subadult polar bear (n = 1) or a human imitation of a grizzly bear barking (n = 1). In instance where the researcher blasted a freon-powered horn at approaching polar bears (n = 31), the bears were less likely to continue the approach, in comparison to instances in which the researcher aimed the freon-powered horn at the polar bear without blasting it (n =10). Another article (Appelby et al., 2017) also evaluated a handheld air horn for its potential to manipulate dingo (*Canis lupus dingo*) behaviour on Fraser Island, Australia, in comparison to a simple whistle, but observed no successful deterrence situations involving the air horn. Finally, Sarmento (2024) evaluated the effect of motion triggered solar alarm lamps, a combination of sound and light deterrence, to deter grizzly bears (*Ursus arctos*) from farms with unsecured agricultural attractants. Video recorded bear visits revealed that a higher proportion of bears obtained attractants when the alarms were off (58%, n = 221) than when the alarms were activated (43%, n = 226).

2.3.2 Secondary repellents

Secondary repellents aim at making the animal learn to associate a certain behaviour with discomfort, ultimately achieving aversive conditioning. This is doable in theory, but very difficult to use successfully on wild animals, particularly predators. Even when the aim of the intervention often is to teach the predator to associate a particular behaviour with discomfort, what is achieved is more often to scare it away from the site at that particular time (Gehring et al., 2006).

There are a series of conditions that need to be taken care of for maximizing the effectiveness of secondary repellents, and one of them is that the animals should be able to recognize the situations where the negative experiences have been experienced. Deterring animals from visiting a particular place or exhibiting a particular behaviour, in order to promote aversive conditioning, has been tested on several species (Kloppers et al., 2005; Conklin et al., 2009; Woods et al., 2007; Jenkinson 2010); although it seems more challenging in predators (Shivik et al., 2003). In addition to being resource-intensive (Gillin et al., 1994; Rauer et al., 2003; Dolson 2010; Mazur 2010), the use of projectiles, for example, can also result in injuries which, at least in the case of bears, appear to be mostly mild and short-term (McCarthy & Seavoy 1994). Skrbinsek & Krofel (2014) reviewed the experiences with bear deterrence in Europe and reported that the scaring measures considered to have the best effect are those that cause pain to the bear. However, even in these cases, the measure seems to have a short-term effect, at best 4-8 weeks (Derocher & Miller 1985; Rauer et al., 2003; Beckmann et al., 2004; Huffman et al., 2010; Mazur 2010). In cases where it has been considered that aversive conditioning was achieved, the number of repetitions of the stimuli has generally been high. There are no studies available that provide a general rule for how many repetitions are needed to expect any effect, but usually 1-12 repetitions are recommended for bears (Gillin et al., 1994; Dolson 2010; Mazur 2010; Groff et al., 2013). However, there are cases where more than 20 repetitions for the same bear have not resulted in a lasting effect.

Summary of evidence on the use of hazing from the systematic review

Four articles evaluated an active scaring, or hazing, of American black bears and pumas (*Puma concolor*) to deter them from interacting with humans or causing nuisance. In the first study (Leigh & Chamberlain 2008), black bears were captured and immobilised following nuisance complaints that were assigned to hazing with various stimuli including dogs (n = 6), moved on average a further distance from the capture site ($\bar{x}$ = 1940 m, SE = 373) than did the bears (n = 5) that were hazed without dogs ($\bar{x}$ = 1235 m, SE = 437) over a 24 hour survey. After 14 days, the bears treated with hazing and dogs had increased their average distance to the capture site further ($\bar{x}$ = 2091 m, SE = 417) in comparison to bears hazed without dogs ($\bar{x}$ = 1172 m, SE = 421). The second study (Breck et al., 2007) evaluated the effect of an alarm system at campsites in California, USA. The alarm would alert management personnel to search and haze bears when transmitters worn by visiting bears activated the alarm (n = 59) in relation to visits when the alarm was inactive (n = 94). The study found that there were on average a lower number of bear visits/night when the message transmitter was active than when inactive, likely due to an increased detection rate. Finally, the third study (Beckmann et al., 2004) evaluated a combination of deterrents (pepper spray, 12-gauge rubber

buckshot, rubber sluch, cracker shells, and yelling, n = 21) and deterrents combined with dogs (n = 20), and a control group that were captured but released on site without any hazing (n = 21). The number of days that elapsed before bears returned to the capture site was larger among bears in the deterrent group ($\bar{x}$ = 88.4 days, SD = 76.5) and the deterrent and dogs group ($\bar{x}$ = 154 days, SD = 202) than in the control ($\bar{x}$ = 64.6 days, SD = 103.9). Finally, Parsons et al. (2025) evaluated the effect of hazing with dog once, twice, or three times to increase puma sensitivity to human presence measured by their flight initiation distance. While the flight initiation distance for control pumas decreased with the number of trials, the flight initiation distance increased from the first trial ($\bar{x}$ = 74.8 m, SE = 9.6) to the second trial ($\bar{x}$ = 94.2 m, SE = 9.2), the third trial ($\bar{x}$ = 134.0 m, SE = 16.1), and the fourth trial ($\bar{x}$ = 128.1, SE = 11.7).

Summary of evidence on the use of chemical deterrents from the systematic review

Three articles evaluated application of chemical compounds to deter access by carnivores to bait sites or previously used areas. In the first study (Shivik et al., 2011), natural openings within coyote (*Canis latrans*) territories (n = 3) in Texas, USA, were randomly assigned to either be treated (n = 5) with a peripheral spraying of coyote urine, or to a control (n = 5) around which the researcher simply walked without spraying urine. The intention of spraying urine from unknown coyote individuals was to deter the resident coyotes from entering the plots, but results from study suggest the opposite effect where coyotes expressed a higher visitation rate to treatment plots than to control plots during the 4-week study. The second article (Miller 1987) evaluates the effect of seven chemical repellents to deter polar bears from baited sites in Manitoba, Canada. In comparison to a site with untreated bait (n = 1), polar bears spent less time at baited sites treated with Halt (n = 1), Chaperone (n = 1), Bear Trail (n = 1), Git (n = 1), Scam (n = 1), Pine Sol (n = 1), and Ammonia (n = 1). Finally, McCarthy and Seavoy (1994) evaluated the effect of placing honey and peanut boluses treated with Thiabendazol on trash cans, in comparison to placing honey and peanut boluses without the compound on containers. There was no observed difference in the number of bear visits to treatment and control cans and the removal of garbage by bears was not reduced. Significantly fewer boluses of both treatment and control type were observed between the early (19) and latter part (0) of the study period, suggesting a learned avoidance of boluses.

Summary of evidence on the use of shocking devices from the systematic review

Five articles focused on the use of electric shock devices to reduce carnivore access to bait-sites or garden attractants. Three articles evaluated the effectiveness of shock collars to reduce access to bait sites by wolves in Wisconsin, USA. The studies are suspectedly linked to each other but are presented separately at this point. In the first article (Gehring et al., 2006), the authors present preliminary findings from a field experiment where they observed a reduced use of bait-sites among treatment wolves (n = 5) compared to control wolves (n = 5) over a 14-day shocking period. Over an extended 40-day shocking period they observed a reduced visitation rate (#days/40-day period) to the shocking zone among treatment wolves (n = 5) compared to control wolves (n = 2). In the second article, the same authors (Hawley et al., 2009) present the effect of shock collars to reduce visitation rate to the bait sites in Wisconsin by treatment wolves (n = 5) compared to control wolves (n = 5)

over a 14-day shocking phase and a 14-day post-shock phase in relation to a 14-day pre-trial phase. They found that the visitation rate was reduced among treatment wolves during the shocking phase, but that the effect was less pronounced during the post-shock phase. Finally, Rossler et al. (2012) evaluated the amount of time treatment and control wolves spent daily in the shock zone while wearing the shock collar. A larger reduction was observed among control wolves, but it should be noted that their use of the shock zone during the reference period was higher than the treatment wolves' use of the area, so it is doubtful if these are comparable.

Two studies have evaluated electrified devices for their effect in deterring American black bears from obtaining food sources. First, Breck et al. (2006) tested the effect of the Nuisance Bear Controller for preventing damage to bird feeders. While 4 of 10 control bird feeders were destroyed, no treatment bird feeders were destroyed during the study period. Otto & Roloff (2015) evaluated the effectiveness of different electric fence designs to prevent American black bears from entering a bait site in Michigan, USA, in relation to a basic electric fence with two 1.3 cm polytape wires at 0.23 and 0.58 m above the ground (n = 2). They found that placing the two polytape wires at 0.23 and 0.48 m above the ground (n = 2) reduced proportional bear breaching incidence into baited sites, but with an additional inset wire at 0.15 m (n = 3) no effect was observed. When placing three polytape wires at 0.23, 0,39, and 0,58 m above ground (n = 2), they once again observed a reduced proportional breaching occurrence into the baited site compared to the basic fence. Observed inconsistencies in these results suggest that they should be interpreted with caution. The duration of the trial was time-limited (2-5 nights), and the same bears repeatedly interacted with the fences.

2.4 Removal of wolves

Removing wolves may be an effective intervention if the cause of the risky situation is one wolf/group of wolves that are more likely to cause such situations, compared to the average wolf likely to colonize the area after the removal. Our systematic review has not found any studies where it is possible to make any conclusions on the effect of removal as an intervention to reduce the likelihood of risky situations (or the link between wolf density and wolf habituation to humans, see Frybova et al., 2025). It is, however, obvious that removing wolves has the potential to be very effective, given that it is possible to determine that the problematic situation is just caused.

Summary of evidence on the use of removal from the systematic review

Two studies have evaluated relocation of American black bears as a measure for reducing repeated nuisance behaviours. Weaver et al. (2003) compared repeated nuisance among male bears that were either captured and released <5 km or relocated >8 km to a wildlife management area and found that released bears (n = 11) were more likely to repeat nuisance behaviour (72.7%) than were translocated bears (27.6%, n = 58). White et al. (2022) found a lower proportion of relocated bears recaptured for management purposes (13%, n = 24) than was observed for bears that were released on site (39%, n = 70).

3. Recommendations

3.1 Introduction to DAIDAR

The increased public concern observed across Europe on the potential outcomes from close interactions between wolves and people requires a set of guidelines on how to manage situations involving strong habituated and bold wolves by authorities, in order to ensure an adequate, appropriate, and prompt management of eventually risky situations. Not all situations involving wolves near to humans do require all possible interventions, and we strongly recommend considering the interventions in the following order:

1. **D**ocumentation
2. **A**ttractants
3. **I**nformation
4. **D**eterrence
5. **A**versive conditioning
6. **R**emoval

Using the acronym **DAIDAR** can make it easier to remember the proposed order. Since scientific evidence is scarce when it comes to the effect of interventions aiming at mitigating situations with wolves close to human activities, our recommendations also rest on "best practices", i.e., the shared experience of our working group of managers and scientists working with these issues.

These recommendations are not rules that must be strictly followed. Instead, the recommendations suggest what to do when, and how to do it. If a potential risky situation occurs, we recommend that the first intervention is **Documentation**, since this will be the basis for all further decisions. With the help of the compiled information, it should become clear if **Attractants** are involved. If this is the case, attractants should be **located** and removed or made them inaccessible. If wolves are still repeatedly observed close to inhabited houses, then, **Information** to local residents may be beneficial. Actions to deter wolves may be considered at this stage. If the situation involves strong habituated or bold wolves hazing should be implemented to achieve **Aversive conditioning**. If after active deterrence measures have been successfully implemented (i.e., repeated efforts directly linked to the undesirable wolf behavior), but showed no effect, **Removal** may be an option; particularly if the wolf bites people without being intentionally or unintentionally provoked (although the recommendations suggest an order of interventions, in this case it is recommended to go directly from Documentation to Removal). In these recommendations we use the term repeated observations. In order for observations to be regarded as repeted observations they should be at least 24 hours apart.

The acronym contains an "I" as in information. Information and communication is in practice a part of all the other parts of the acronym as well. Make time for information and communication with affected people when doing field visits to document what has happened, locating attractants, performing deterrence or efforts to remove wolves. Remember that the work does not end with this specific situation, it will continue for many

decades. The ability of authorities to inform and communicate in this specific situation, will however determine peoples willingnes to report and contribute in coming similar situations.

3.2.1 Documentation (DAIDAR)

Rule of thumb for when to use: *Document all situations of wolves near human activities and near humans in daylight.*

The first action to be taken in ALL cases is to adequately document the reported situation at hand in order to provide sufficient information to allow a proper assessment of the situation and justification for choosing to intervene and select how to intervene or not intervene. At this stage, it is strongly recommended to carry out field visits by trained personal in order to get first-hand information. Information included in the reported observations should at least cover:

- Who made the observation
- Who reported the observation
- When was the observation made
- Where (coordinates) was the observation made
- Circumstances: "wolf near human activity" (e.g. inhabited building, vehicle or human on horseback), or "wolf near human" (wolves within 30 m^2 from a person on the ground.
- How close to human(s) (not inside buildings or vehicles or on horseback) was the wolf/wolves as closest
- How many humans were present
- How many wolves were observed (adults, juveniles, pups)
- What was the condition of the wolves (checking for illness, injury etc.)
- What activity was the human(s) engaged in)
- Potential attractants (food remains, wild prey, pets, livestock, etc.) found on site
- Potential problematic human behavior in the area (feeding of stray dogs, feeding of wildlife…)
- Who did the documentation

If the wolf/wolves are still on site when the field staff arrives, they are advised to walk towards the wolf to document at what distance from a lone person the wolf/wolves start to retreat (increase distance).

Which intervention is likely to be effective in each area depends on the type of the situation that has arisen AND an assessment of its origin and likelihood of recurrence. **When** to use a particular intervention is decided based mainly on the risk for attacks on humans (Figure 1).

[2] The distance of 30 meters is chosen from ballistics tests that report significant changes to trajectory and energy of rubber bullets shots at distances higher than 30 meters, as well as the likelihood that the wolf is actually aware of the presence of one or more humans.

Which type of intervention should be used in a given situation is decided based on the assessment of what likely caused the problem.

On an overarching level, the origin of the potential risky situation may be divided into three different categories. Each category will require different interventions and/or different applications of interventions. The documentation carried out on site when situations of wolves near human activities and near humans occur should aim at determining which of the three following categories a particular situation falls into. **The first two situation types often have their cause in the behavior of people:**

Individuum based situation

The situation arouses from a certain individual (less common a group of individuals) that has learned and exhibits an undesirable behavior. Frybova et al. (2025) documented that 75% of reported cases of strong habituated and bold wolves compiled between 2012 and 2022, in 75% of cases a single wolf was involved. In this case, interventions such as active deterrence measures or removal, if needed, targeting these individuals has potential to be effective. The individuum may have learned this behavior through human misbehavior like intentional feeding (food-conditioning) or people repeatedly approaching juveniles. From the reported cases included in Frybova et al. (2025) physical contact occurred in cases involving wolves that were likely captive and/or highly food conditioned over a long period.

Location based situation

The situation arouses from a particular site where there are, for example, one or more places with wolf potential prey items (e.g. wild prey, garbage, cats or dogs, unprotected livestock, livestock or dog carcasses) that attract wolves close to inhabited buildings or towards people (e.g., people accompanying dogs), and where the average wolf would be expected to generate the same situation. Location based situations may also be related to human behavior like feeding of wildlife that can create a habituation of wolves to humans. To resolve such situations, the most important interventions are those that bring about a change in, for example, the availability of elements that can attract wolves near humans and/or the cessation of human behaviors facilitating habituation.

Isolated events

An example of an isolated incident may be when wolves seek or chase prey, and the chase ends up in, or on the edge of, a village or garden. The wolves may then visit the carcass for one or more days afterwards without this being expected to lead to changes in wolf behaviour or future risky situations in the area. In the case of isolated incidents, it is not justified to take any long-term measures, as the situation is unlikely to recur anyway; but documentation is still necessary and, depending on the situation, information.

3.2.2 Attractants (DAIDAR)

Rule of thumb for when to use: *Attempt to locate potential attractants when there have been more than 3 observations (>24 hours apart) of wolves less than 30 m from humans or less than 30 m from inhabited buildings in daylight, during a period of 30-90 days.*

Especially in areas where wolves have recently become established, awareness of what might attract wolves is generally quite low. When there have been repeated observations documented in the same area, plot reports of wolf sightings on a map and again visit at least those places where there are two or more sightings within 500 m of each other to search for potential attractants. Also, an untrained dog can be a valuable tool when it comes to finding these spots. If there is snow, time should be set aside to follow wolf tracks to determine whether there are one or more places that are visited more often than others. **If it is possible to remove attractants this is the preferred intervention.** If this is not possible, make the attractants less accessible to the wolves by using barriers or deterrents. Attractants were at least partly known in 85% of cases of strong habituated and bold wolves reported by Frybova et al. (2025).

3.2.3 Information (DAIDAR)

Using a website and/or social media to provide information about what has been documented and what measures will be taken often require a limited amount of work and makes it possible for those interested in seeking information to find it. Regularly posting information makes it easier for the public to follow the development of events in various situations and thus also provides better conditions for understanding and anticipating the decisions made by the authorities.

Information meetings restricted to participants who are directly affected by the current situation should be prioritized over large information meetings. At smaller meetings it is easier for people to share information and to have a constructive discussion about how the current situation should be handled than at a large meeting with representatives of various interest organisations and people who are generally interested in the issues. Regional and national wolf management is of course important to discuss, but preferably in other forms.

An information meeting should cover at least the following points:

1. Establish a common ground for further discussions by presenting the reports received from the public and what has been documented so far highlighting the decisive role of attractants to wolf behavior if present/defined in the area. Also ask if there are additional observations that have not yet been shared.
2. Give an overview of experiences from other similar situations. What actions were taken and what were the results?

3. Give an overview of the recommendations in this report. Conclude by explaining what interventions are planned and what the next steps will be if these do not have the desired effect.
4. Allow plenty of time for questions from participants. This is important for several reasons, e.g. there may be important issues that have not been addressed in the presentations.

5. Define and involve in the meetings competent authorities that may need to be present and have a role in the management of the cases

An evaluation of the effect of information meetings in connection with concerns about wolves in the vicinity of inhabited homes and people (Johansson et al., 2016) shows that the meetings have a direct effect, but that the effect largely depends on the extent to which the participants feel confident that what is presented is correct. **In order to maintain or even increase confidence in the authorities' way of dealing with large carnivore issues, it is important that presentations are well prepared and that all promises made can and will be fulfilled.** It is at least as important that those attending the information meeting gain or have confidence in the presenter as what is said. In most cases, it is advantageous to use personnel who have sufficient knowledge to be able to answer the questions asked and who are also used to giving presentations.

Always bear in mind that people who attend the information meeting are concerned about the situation that has arisen and uncertain about what it may lead to. **It is therefore important to keep in mind that the managers or field staff attending the meeting should have a "listening" approach to the meeting rather than an informative one.**

The evaluation carried out by Johansson et al. (2016) also showed that there are many different reasons why people visit an information meeting, such as to hear what others in the community have to say and to gauge the atmosphere rather than to listen to the presentations. It also emerged that the participants carefully observed who was or was not allowed to speak and that it could be perceived that the authorities did not want to allow certain people to ask questions. Interestingly, even though the information meetings did not result in a large reduction in fear/concern or a large increase in confidence in authorities, there were no signs that they brought anything negative with them. The conclusion is therefore that **organizing information meetings comes with minimal drawbacks**.

*3.2.4 Deterrents (DAI**D**AR)*

Deterrents and barriers where the expected effect is that the wolf will leave or avoid the area, or to prevent the wolf from accessing to a particular place, as long as the intervention is implemented, can be used by anyone at any time. **The earlier a wolf is deterred in a potential risky situation, the better.** Deterrents may not only be scarecrows, devices with humans voices, or other light/sound scaring devices, but can also be people throwing sticks and stones, or shouting, clapping hands and approaching a wolf; and barriers can be, for example, electric fences or fladry. After an attractant has been successfully removed, wolves

may on some occasions come back to the site to check. In these cases, deterring the wolf may lead to fewer visits. It is important to recognize that starting with relatively mild deterrents and then gradually increase the severity may result in habituation to deterrents as well as humans. The recommendation is thus to from the start use the most severe deterrant available for use in the explicit situation. Trained staff is most often able to provide more severe deterrence than local residents are.

Rule of thumb for when to use: *Use deterrents when attractants have been located in order to make attractants less accessible to wolves or to deter the wolf from a specific route or object.*

3.2.5 Aversive conditioning (DAIDAR)

Rule of thumb for when to use: *If observations of wolves within 30m of a human walking towards the wolf continues after potential attractants have been removed or made inaccessible for the wolf (or if it has been deemed impossible to remove attractants) and deterrents and barriers have been used unsuccessfully. Is possible, it is recommended to capture a radio-collar the individual to increase the intensity of applying deterrents and to increase the chances of promoting aversive conditioning.*

The general rule when using aversive conditioning is to start with the hardest/most discouraging treatment at once. This minimizes the risk of habituation to the negative stimulus. In cases where a wolf undesirable behaviour needs to be prevented, it is usually difficult to use electricity or noxious substances. Instead, we have to rely on various types of projectiles that cause the animal pain or pyrotechnics with loud bangs and bright lights bursting near it to bring high levels of discomfort. This creates some practical problems in terms of delivering the projectile or burst in such a way that the wolf has a chance to associate the discomfort with people or inhabited buildings. Anyone who has tried to use punishment to change a dog's behaviour knows that this requires both timing and precision when the punishment is administered in order for it to be linked to a specific behaviour. Often more than one punishment is needed, and the more difficult it is to achieve timing and precision in practice, the longer it takes for the dog to understand the link between behaviour and punishment. Some dog owners spend years and thousands of punishment sessions trying to teach their dog not to sleep on furniture or pull on the leash when walking. The idea that we can use punishment as a method to eradicate a specific behaviour of a wild animal, with at best a handful of punishments, is optimistic to say the least.

There are some examples in the literature on the outcome from hazing on wolves. In Yellowstone National Park, USA, Smith et al. (2020) report 55 wolves displaying habituated

behavior on 127 occassions. Of the 55 individuals, 49% changed their behavior after being hazed. A collared wolf in Italy was shot with rubber bullets and reserachers compared the behaviour of the animal before and after the intervention (Zanni et al., 2023). After the intervention the wolf changed its use of space by increasing distance from humans and ceased to attack farms in the following 2 months.

There are many different types of ammunition developed for non-lethal effect, primarily on humans. Whether it is a rubber bullet, bean bag or plastic projectiles is probably less important than the shooter's ability to judge distance and select the appropriate ammunition type and strength of charge. For example, firing a projectile designed for use at 70-90 m at a wolf standing 30 m away is very likely to result in serious injury or death and therefore risks creating more problems than it solves. Rubber or plastic shotguns can be very useful at distances up to 15-20 m as the impact energy of the bullets is low. At greater distances, the relatively poor accuracy combined with the movement of the wolf means that the risk of a hit in the eye is high.

Personnel who are expected to carry out operations against live animals with projectiles should train with the different types of ammunition in different locations beforehand.

When projectiles are used, they should primarily hit soft tissues in the back of the body. Ribs, legs or head should not be hit as this can lead to fractures or eye injuries. When non-lethal projectiles are fired at a wolf, the effective impact area is the same size as an ordinary dinner plate. Non-lethal projectiles do not have the same accuracy as regular ammunition and in practical use it is difficult to achieve the required accuracy at distances exceeding 30 m. We therefore recommend that non-lethal projectiles are only used when it is possible to fire them from a maximum of 30 m.

Requirements for aversive conditioning to be possible: a) it is possible to hit the wolf with projectiles or pyrotechnics and b) it can be assumed that the wolf is likely to associate the discomfort with the object, event or location at hand. **In order for this intervention to have the intended effect it is necessary that the wolf learns to associate a certain object, event or location with pain/discomfort.**

In most cases, this means that this intervention should only be used where it is possible for a human to walk towards the wolf and get to a distance of less than 30 m before the wolf moves away. The smaller the area over which the wolf moves, or the more regularly it visits certain locations, the greater the chance of successful intervention. In cases where the wolf moves over a large area and observations are called in to a person who is expected to go to the site, the wolf will usually have left the site by the time the person arrives. If the wolf remains at the site, the movement and sound of a suddenly approaching person means that the wolf often moves away at a distance of more than 30 m. If the staff are able to get a projectile off, the wolf is likely to associate the discomfort with the sudden arrival of people at a site, but it may still remain in the vicinity of people who are stationary or moving slowly. Along these lines, **in order to maximize the success in promoting aversive conditioning when the interventions are intensified, capture and radio-collaring may be beneficial.**

An example of a situation where there is a higher probability of at least succeeding in hitting the wolf with a non-lethal projectile is when a wolf visits the same location daily and does

not move away from people moving within 30 m of it (i.e., a strongly habituated or bold wolf). An example of a situation where there is a lower likelihood of success with a non-lethal projectile is when one or more wolves visit several different locations with several days between visits and also avoid people at a distance of more than 30 m. If it is difficult for field staff to get within 30 m from the wolf for several days in a row, aversive conditioning is probably not the most effective solution to the problem, and other interventions should be considered.

When deciding to use interventions to promote aversive conditioning, it is important to specify when to end it for the following reasons:

Ethics/Animal welfare – This intervention will cause the wolf to suffer, to keep the suffering to a minimum it is a good idea to set a clear end point.

Fear - Residents in the area will benefit from knowing for how long the situation will continue.

Economy - This intervention demands a lot of time and personnel.

It can be useful to set a time limit in advance, for example: If the period of aversive conditioning has had **five occasions where the wolf was hit effectively** with a rubber bullet or other repellent, **or a period of 14 days has passed** (where the wolf is still there displaying the undesirable behavior), whichever comes first, the intervention is ended. If the result is that the risky situation stop, then we may consider that aversive conditioning has succeeded. If the problematic situations did not stop after 5 hits with projectiles, more projectiles will likely not lead to a different result. If it was not possible to fire projectiles at the wolf five times, or even one time, this intervention may not be suitable in that case.

3.2.6 Removal of wolves (DAIDAR)

Rule of thumb for when to use: *If observations of wolves within 30m of a human walking towards the wolf continues after aversive conditioning (five hits or 14 days) or removal of attractants, or if aversive conditioning or removal of attractants has been deemed impossible, or if the wolf has physically injured a human.*

Removal can be achieved in different ways, it may be through culling the wolf, but it may also be achieved through capture and relocation of the wolf. Capture and relocation are most often more time demanding and expensive. Another issue may be that the wolf individual is stigmatised and very few people want it to be relocated to the area they live in. Relocated wolves are recommended to be radio-collared before release. On the other hand, culling of wolves may in some places be very controversial and create conflicts. It can often be difficult to determine if it is one wolf that has visited different locations, or several different wolf individuals that have been observed.

A criterion that states that the wolf may be shot or captured if it is within 30 m of humans will, with a high degree of likelihood target the individual or individuals that have appeared close to humans even if it has not been possible to definitely determine if it is one or more wolf individuals that has been observed.

In the case of wolves that are repeatedly observed close to humans, culling as well as capture and relocation is easy to carry out. If it is difficult to get close enough to shoot or capture the wolf, the danger to human health and safety is also less imminent.

In situations involving physical attacks by wolves on humans it is extremely important that the documentation is precise and thorough. Otherwise it will not be possible to determine if the wolf is to be considered potentially dangerous to humans, or if the physical attack was purely due to human provocation. A wolf that for example bites a researcher during trapping and/or radio-collaring is not necessarily a wolf with an increased likelihood of attacking humans.

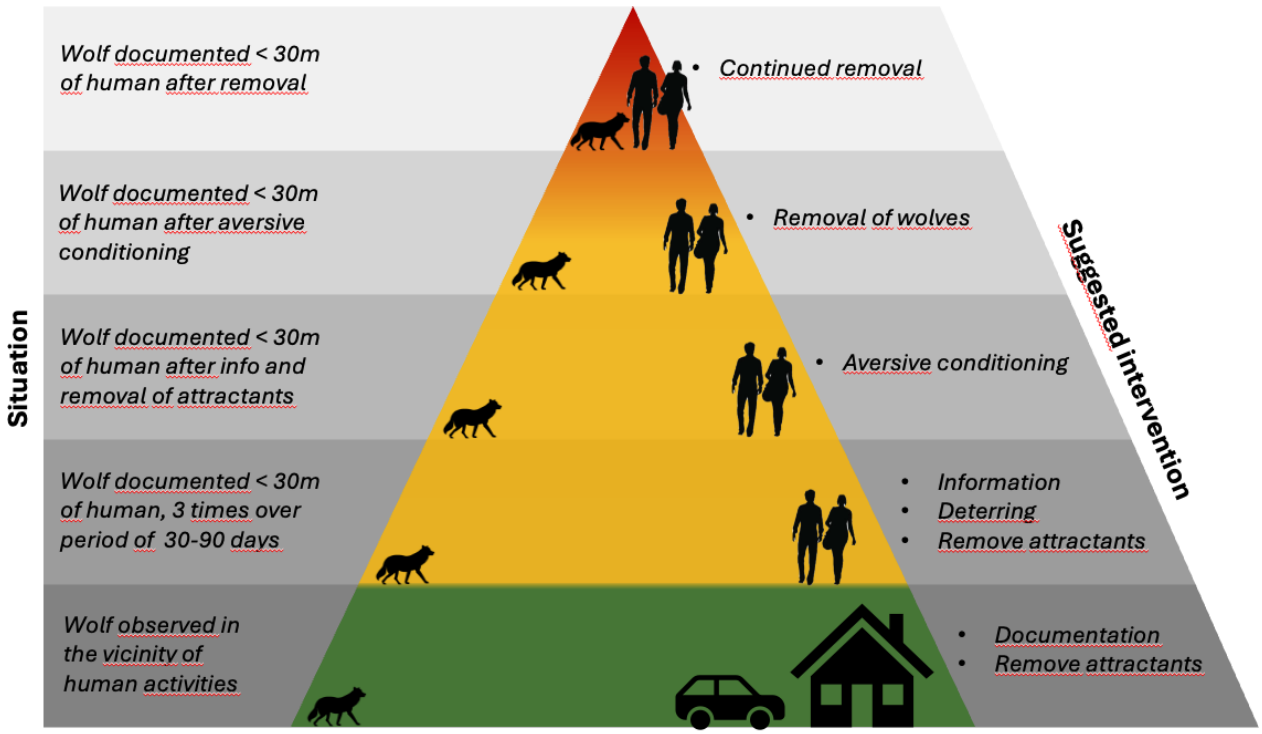

Figure 4. *Overview of situations and suggested interventions.*

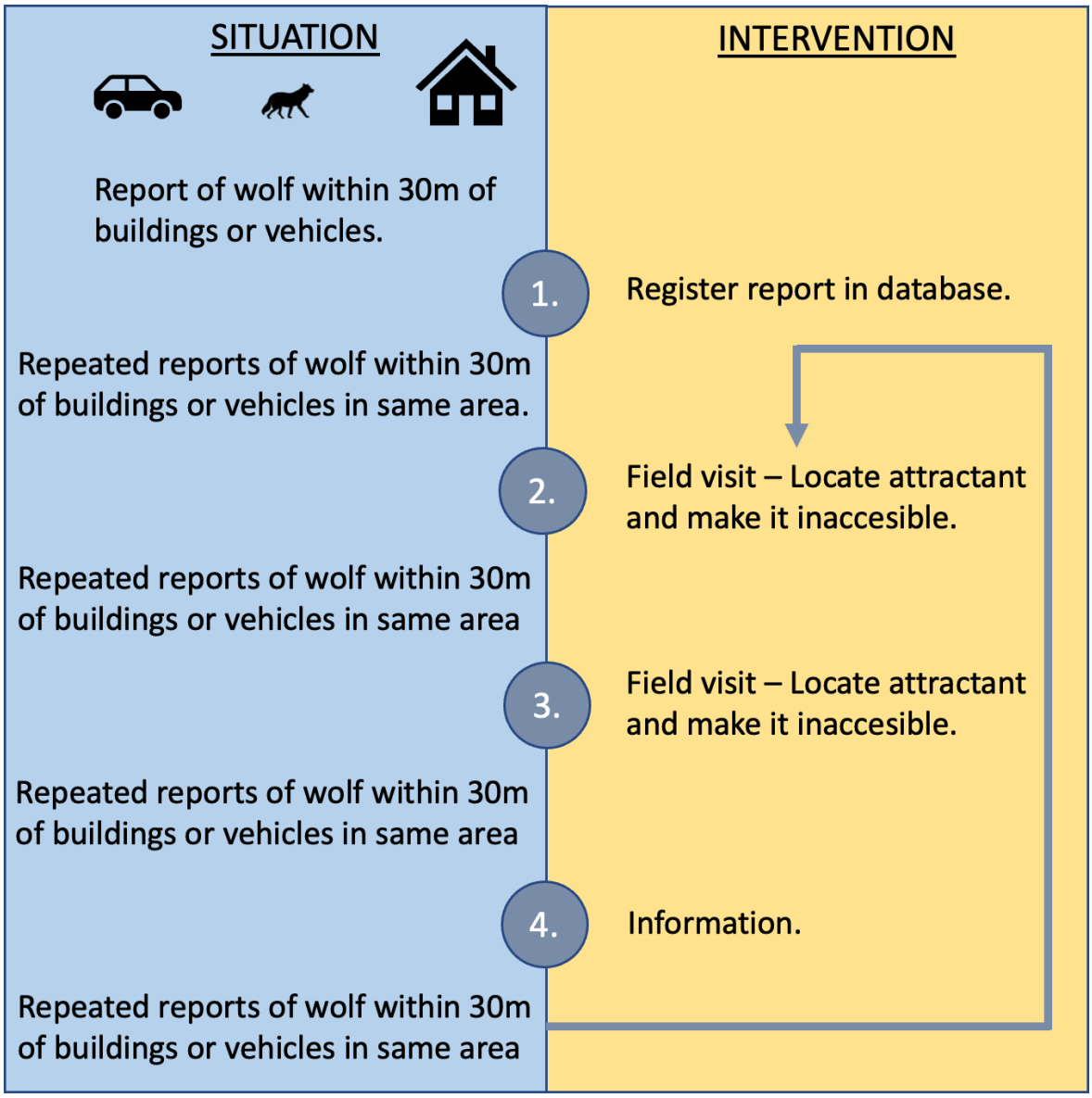

Figure 5. *Schematic presentation on protocol for management of typical situations involving wolves close to vehicles or houses (also for example humans on horseback and similar situations).*

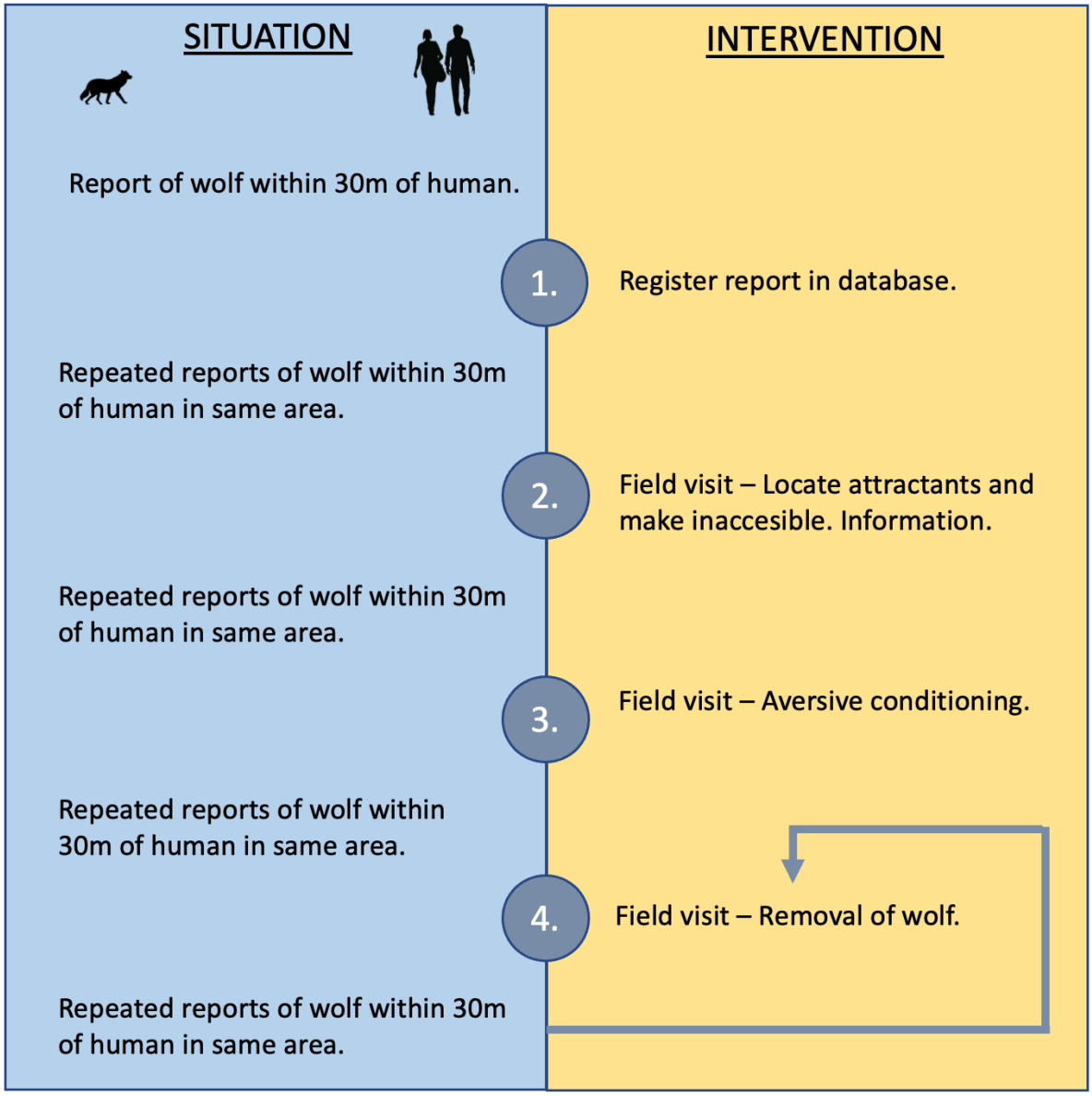

Figure 4. *Schematic presentation on protocol for management of typical situations involving wolves close to humans.*

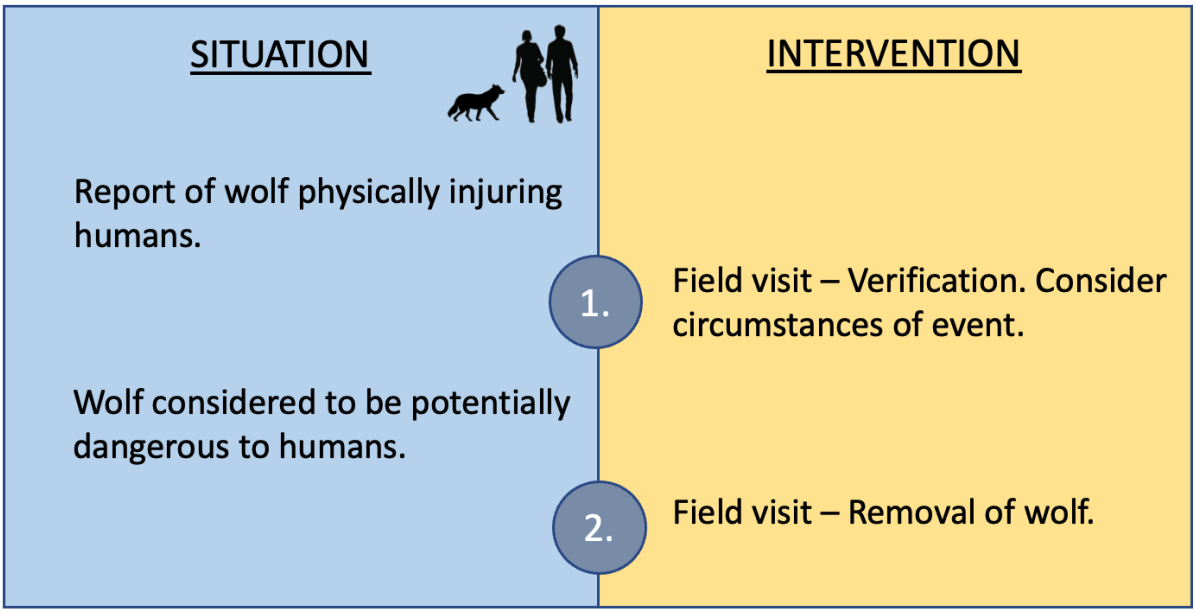

Figure 4. *Schematic presentation of protocol for management of situations involving wolves physically injuring humans.*

4. Evaluation of the effectiveness of interventions

There is a lack of studies on the effects of the different interventions currently used to manage situations with wolves close to humans. If we are interested in learning more about their effectiveness, we sometimes need to use an **adaptive management approach**. Adaptive management focuses on learning by doing and aims to reduce uncertainty about the effects of different management interventions. Setting goals, using interventions, and then following up whether the goals have been achieved or not, is not an example of adaptive management. While an adaptive management model requires setting concrete goals, in the short term it is more important to learn more about which interventions work and why they work. Adaptive management is for that reason sometimes also referred to as 'management by experimentation', as the model focuses on implementing management interventions using the same approach as in scientific experiments. When it comes to interventions to reduce the likelihood of risky situations to people, experiments are scarce and new interventions are still being developed or piloted.

In situations where authorities are not willing to invest time and effort into an adaptive management approach, it will still be possible to gain some information on the effect of interventions if **one intervention is used at a time**. Whenever we use more than one intervention at the same time and place, we decrease or lose the possibility to draw any conclusions on their effectiveness.

It is also important to understand that if we want to learn more about the effect of the protocol and different interventions recommended here, we need to use the protocol in EVERY situation. Otherwise, the results will be skewed by the situations in which we choose to apply it. If most countries apply the recommendations given here only in less severe situations with wolves close to humans, we are at risk of greatly overestimating the effectiveness of the protocol and interventions.

5. Preparations to facilitate management of situations with wolves near humans

In order to follow a structured work process, preparations are required. It is particularly important to establish effective contact between different authorities, especially between wolf managing authorities and police at an early stage. For the practical work, it is a great advantage if the administrative boundaries are as unnoticeable as possible, which allows both personnel and equipment to be “borrowed” from each other.

Preparations to **document** what happened and, in some cases, to **identify** one or more wolf individuals.

- Access to experienced field staff who can document a reported observation or incident within 24 hours of report.
- Access to a trained tracking dog that can be used to track wolves.

- Authorization to be able to set up camera traps and also have a set of at least 5 cameras with MMS function available.

Preparations to effectively **implement interventions to** deal with situations involving wolves close to humans.

- Establish procedures to activate staff with a special responsibility to assist in situations where wolves are close to houses or people by setting up camera traps, locating attractants, or using deterrents.
- At least one set of sound scaring devices, e.g. two "Critter Gitters" or equivalent units of another brand.
- In areas with wolves, field personnel should have access to at least one set of 400m fladry with 40 lightweight plastic or fibreglass fence posts to be used for making attractants unavailable.
- At least one person who is trained to fire projectiles at wolves in order to do aversive conditioning.
- Access to dog teams that can be used to track and if needed shoot wolves.
- Access to people experienced in capturing and radio-collaring wolves.
- Well-conducted wolf monitoring.

6. Legal framework

Under the pan-European Bern Convention, most European countries are under an obligation of result to ensure minimum wolf population levels that correspond *inter alia* to "*ecological … requirements*" (Article 2). Furthermore, in most European countries, wolves are a 'protected species' under the Convention, listed in its Annex III. This entails that competent authorities "*shall take appropriate and necessary legislative and administrative measures to ensure the protection*" of wolves within their territories (Article 7). Under the 1992 Habitats Directive, EU Member States are under a general obligation to take the measures necessary to ensure a "*favourable conservation status*" for wolf populations on their territories (Article 2). In addition, wolves in most EU member states are covered by area protection (Annex II) and species protection (Annex IV/V) obligations.

Regarding species protection, where the flexible protection regime of Annex V applies, the Directive requires EU Member States to systematically monitor wolf populations (Article 11); to take the measures necessary to ensure a favourable conservation status (Articles 2(2) and 14); and to outlaw certain means and modes of capture and killing (Article 15), except when authorized under the strict conditions of Article 16.

Both the Bern Convention and the Habitats Directive must be read and applied in light of the objectives set out in the non-binding but authoritative Global Biodiversity Framework (GBF) that was adopted in 2022 by the parties to the Biodiversity Convention, and which provides the global compass for biodiversity policy and law in the coming years. A particularly relevant target in the present context is to promote human-wildlife coexistence while minimizing human-wildlife conflict (GBF Targets 4).

The effective management of strong habituated and bold wolves in accordance with best practice guidelines, insofar as such management must be regarded as serving the interest of the conservation of the wolf population(s) concerned, will generally align with the various obligations and commitments outlined above, and may indeed be necessary to comply with them (Trouwborst 2025). Depending on the circumstances, this may entail, among others, awareness campaigns, the enactment and enforcement of restrictions for people (e.g., prohibitions to feed wolves, and access limitations regarding certain parts of wolf habitat), and the monitoring, aversive conditioning, and when all else fails the removal, of certain wolves.

It is advised that no interventions are planned without considering current legislation and court rulings.

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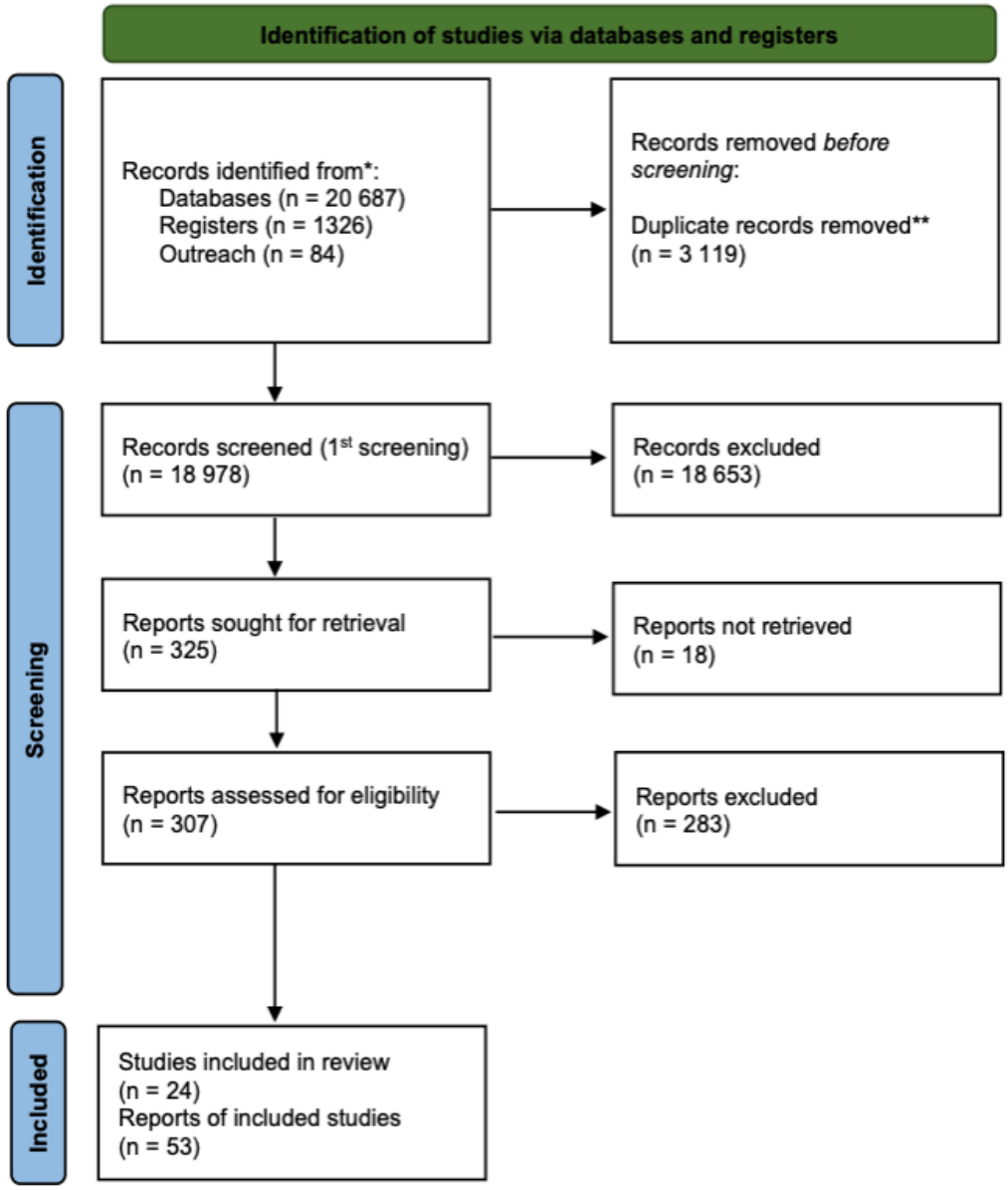
Appendix I: *PRISMA diagram of the review process.*



* Zoological Record & Biosis Citation Index (n = 15 138), Scopus (n = 5 549), Registers: USDA (n = 140), NINA (n = 82), Wildlife Institute India (n = 1104). Outreach includes both returned titles and checked references.

** Duplicates were detected using Rayyan.ai online tool. All duplicates were screened by a human screener before they were removed.

Appendix II

Examples of situations and recommended interventions

Situation	Intervention
Wolf observation in the outskirts of a village has been documented. Wolf passed during nighttime within 50m from buildings. No humans were present outside buildings.	1. **D**ocument

Situation	Intervention
Wolf observation in the outskirts of a village has been documented. Wolf passed during the daytime within 10m from buildings. No humans were present outside buildings.	1. **D**ocument

Situation	Intervention
Wolf do not run away immediately when seeing vehicles or humans. Stops and observes.	1. **D**ocument

Situation	Intervention
Wolves are seen using parts of urban areas (e.g., cycling paths, urban parks, restaurant parkings, etc.).	1. **D**ocument

Situation	Intervention
Wolf observation on a farm has been documented. Wolf feeding on waste from slaughter within 100m from buildings. No humans were present outside buildings.	1. **D**ocument 2. **A**ttractants located and removed

Situation	Intervention
Wolf is seen over several days less than 30m from inhabited houses (multiple events over a long time period).	1. **D**ocument 2. **A**ttractants located and removed

Situation	Intervention

Wolves are seen using recreational areas highly frequented by people (e.g., sandy beaches).	1. **D**ocument 2. **A**ttractants located and removed 3. **D**eterrence

Situation	Intervention
Wolf observation on three different farms has been documented. Wolf feeding repeatedly, over the course of two weeks, on waste from slaughter within 100m from buildings. No humans were present outside buildings.	1. **D**ocument 2. **A**ttractants located and removed 3. **I**nformation

Situation	Intervention
Wolf observations in a village during three weeks. Wolf courting farmdogs more or less every night within 30m of buildings.	1. **D**ocument 2. **A**ttractants located and removed 3. **I**nformation 4. **D**eterrence 5. **A**versive conditioning or removal

Situation	Intervention

Wolf repeatedly allows people to approach it within 30 m.	1. **D**ocument 2. **A**ttractants located and removed 3. **I**nformation 4. **D**eterrence 5. **A**versive conditioning or removal

Situation	Intervention
Wolf observations in a village during three weeks. Wolf courting farmdogs more or less every night within 30m of buildings. Repeated observations are documented inside the village also after deterring. On two occasions humans were at a distance of 15m from the wolf before it went away.	1. **D**ocument 2. **A**ttractants located and removed 3. **I**nformation 4. **D**eterrence 5. **R**emoval

Situation	Intervention
Wolf repeatedly approaches people by itself closer than 30 m. Seems to be interested in people.	1. **D**ocument 2. **A**ttractants located and removed 3. **I**nformation 4. **D**eterrence 5. Aversive conditioning 6. **R**emoval

Situation	Intervention
Wolf repeatedly approaches people by itself closer than 30 m.	1. **D**ocument

Seems to be interested in people. After aversive conditioning, the wolf has again approached a human at a distance of less than 30 m.	2. **R**emoval

Situation	**Intervention**
Wolf observations in a village during three weeks. Wolf courting farmdogs more or less every night within 30m from buildings. Repeated observations are documented inside the village also after deterring. On two occasions humans were at a distance of 15m from the wolf before it went away. After aversive conditioning another documentation was made where the wolf did not leave until a person was within 20m from the wolf.	1. **D**ocument 2. **R**emoval

Situation	**Intervention**
Wolf attacks or injures a human without being provoked	1. **D**ocument 2. **R**emoval