LIFE WOLFALPS EU

Aree Protette Alpi Marittime

Università di Torino

OFB Office Français de la Biodiversité

Parco Nazionale dello Stelvio

ERSAF Ente Regionale per i Servizi all'Agricoltura e alle Foreste

Zavod za gozdove Slovenije

A STUDY ON THE RELATIONSHIP BETWEEN HUMANS, PREY AND PREDATORS

Co-funded by the European Union

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Gaudenzio Canavese: cover illustration and illustration on pp. 14-15
Archive Aree protette Alpi Marittime (pp. 4, 17, 25)
Roberto Audino (pp. 20, 21)
Archive Office français de la biodiversité (pp. 8, 16, 21, 25)
Archive ERSAF-Parco Nazionale dello Stelvio Lombardia (pp. 18, 23, 24, 25, 31)
Archive Slovenian Forest Service (pp. 19, 21, 22)
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Map of Alps on p. 27: Public Domain (commons.wikimedia.org/w/index.php?curid=653130)

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Contents

Introduction

Once spread all over Eurasia, including the Alps, wolves were systematically eradicated and almost driven to extinction in the 19th and 20th centuries. In the last decades, however, wolves began to recolonize naturally the western Alps, through the mountainous corridor of the Ligurian Alps that links the Alps to the Northern Apennines.
The first confirmed pack in the French side of Maritime Alps dates to 1993, while in the Italian side, the first reproductions were documented in the winter of 1996-97 in Pesio Valley. A similar process of recolonization began in the eastern Alps as individuals from the Dinaric–Balkan population dispersed and reached the Alps.
In the eastern Italian Alps (Lessinia) the first pair of wolves established a pack in 2012: it was formed by a male coming from the Dinaric Alps, 'Slavc', and a female coming from the Western Alps, 'Juliet'.

A wolf photographed by a camera trap in Maritime Alps Protected Areas (Italy).

This is the first recorded case of a link between the Italian and Dinaric wolf populations, which have been separated for a century.
The natural and still ongoing comeback of the wolf to the Alps is due to a combination of ecological and conservation factors:

1 ▪ Legal protection, enacted by many European countries in the 1970s and making it illegal to hunt or harm wolves.

2 ▪ Rural depopulation, which has led to reduced human density and abandonment of agricultural land in rural landscapes, leading to the expansion of forests and other habitat suitable to both wolves and their wild prey.

3 ▪ Recovery of populations of wild ungulates such as roe deer, red deer, wild boar and chamois, thanks to the creation of protected areas as well as hunting legislation and reintroduction efforts, often spearheaded by hunters themselves.

4 ▪ The adaptability and resilience of wolves, who are able to travel great distances and survive in a variety of habitats, including in landscapes strongly dominated by human activities. Within their own territory, they can cover tens of kilometres in a single day; during dispersal, they can travel several hundred kilometres within several weeks.

Since the 1990s, the Alpine wolf population has increased from 1 reproductive unit (packs and pairs) in 1993–1994 to 243 units in 2020–2021. The western part of the Alps is almost completely occupied at present and represents one of the main sources of wolf recolonization of the other parts of the mountain chain.

The return of the wolf to parts of its historical range occurs now in a landscape that has been profoundly transformed by humans during the decades or centuries of the animal's absence, leading to conflicts with anthropogenic activities such as livestock rearing and hunting. Wolf recovery affects various human activities and interests, and vice-versa, while triggering social conflicts and differing opinions on wolf management. For solutions of coexistence between wolves and humans to emerge, dialogue and collaboration between stakeholders is vital.

FOCUS 1

Wolf biology

The wolf (*Canis lupus)* is the largest member of the Canid family. Wolves reproduce once a year: the pair mate between January and March, depending on the latitude (in the Alps usually in March) and the gestation lasts about 63 days, as in dogs. Three to six blind pups, covered in short, dark fur are born in dens in spring or early summer.
Following the abandonment of dens, pups are brought to the rendez-vous sites and remain there until they are old enough to join the pack on their hunting trips, which usually happens in late summer or fall. Wolves reach their adult size between ten to twelve months and are usually sexually and socially mature by the age of two.

Wolves often live in packs and are strongly territorial, signalling the borders of their territory through scent marking and howling and hunting collectively. Each pack is a reproductive unit: it is an extended family group led by the two parents (called also 'alfa-pair'), who are generally the only ones who reproduce. In the Alps, packs are composed, on average, of five wolves, but numbers can vary during the year, from two to eleven or more individuals. Usually, the pack is bigger between summer and the beginning of winter, when the pups and individuals of the previous litter have not dispersed to other areas yet.

The territory's size can vary greatly and depends mostly on the density of wolves and prey in each area, as well as the topography of the region and anthropogenic features such as highways. Once a wolf pair settles in an area, it occupies an exclusive territory and constitutes a family group. Wolves use their territory differently in different periods of the year,

depending on the supply of prey and reproductive activities, which include courtship, mating, and raising of pups. Young individuals (2-3 years old) disperse away from their natal pack to find a mate and a new breeding territory. Wolves of both sexes disperse, and there is a high individual variability in how far they disperse: it can be only moving to adjacent territory or anything up to travelling more than 1000 km away. Dispersers are particularly vulnerable to human-caused mortality, such as fatal collisions with vehicles. Wolves are generalist and opportunistic carnivores that can survive on diverse food resources and in different habitat types. Wolves are adaptable, therefore they can prey and scavenge on a wide range of prey, depending on their availability, including domestic livestock. Because they usually prey upon the most vulnerable individuals (i.e. those that are easiest to find and catch), their diet can vary locally and seasonally.

Data on wolf diet in the Alps show that they mainly prey upon large prey, particularly wild ungulates (red deer, roe deer, fallow deer, chamois, mouflon and wild boar). They can supplement their diet by eating carcasses, small vertebrates, invertebrates, domestic animals and even plants. An adult wolf in the Alps needs about 3 to 5 kg of meat per day.

↑ Roe deer photographed by a camera trap in Bauges study area (France).

One of the obstacles for coexistence between wolves and humans in the Alps is the real or perceived impact that wolves have on ungulates. Predators can impact lower trophic levels through direct predation, interspecific competition, or behavioural changes by creating landscapes of fear (▶ FOCUS 2 for details). This concept, first introduced in a study conducted in Yellowstone National Park, suggests that animals adjust their behaviour in response to their perception of predation risk. However, several subsequent studies in Yellowstone have shown contrasting results regarding the actual impact of wolves on the behaviour of their main prey, elk, and consequently on elk herbivory and vegetation growth, in what is referred to as "the trophic cascade hypothesis" (▶ Figure 1). These findings highlight the difficulty of deciphering the complex interactions between prey, predators and their environments due to the inherent intricacies of these relationships.
Adding human presence into the equation leads to even greater complexity, as landscapes and wildlife interactions are strongly impacted by human activities in ways that are not yet entirely clear.
Humans have hunted animals for thousands of years, and nowadays, in a human-dominated world, we are perceived not only as predators, but also as a source of disturbance, when our presence or activities impact animals even though they are not directly aimed at killing them.
In Europe in particular, predator-prey dynamics are thus embedded within human-modified ecosystems, but little is known about the effects of predation risk in these human-dominated settings.

FOCUS 2

The landscape of fear and the role of humans

In an ecosystem, predators and prey can affect each other. The complex relationship between predators and prey influences not just the two species but possibly other parts of the ecosystem through trophic cascades (▶ Figure 1). One impact of predators on prey is obviously predation, and thus injury or death. However, the presence of predators in the landscape can also have consequences, because the risk of being predated can generate fear and lead the prey to change its behaviour.

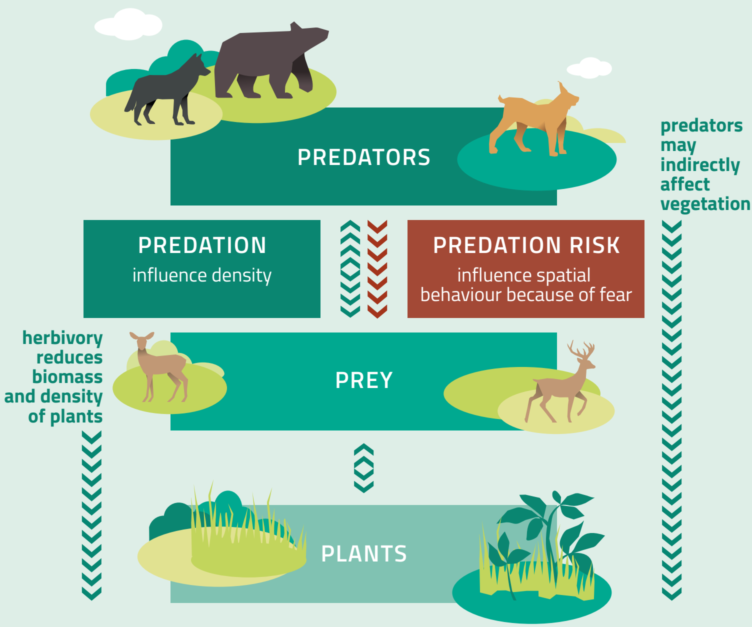


Figure 1 ➔ Trophic cascade on vegetation as induced by predators. In any ecosystem, predators can affect prey populations either by preying on them or by impacting their movements and use of habitat through fear (predation risk). At the same time prey affect predators. If the relationship between the predator, the prey and the vegetation is strong and direct, predators may indirectly influence the growth of the vegetation by impacting herbivory.

Depending on their vulnerability, which is usually related to their size relative to the predator, prey should not only strive to avoid imminent attacks of their predators, but also anticipate where and when possible attacks are more likely to occur.

An animal's decision on how to move and which habitats to select hence depends on a trade-off between the need to acquire food of high energetical quality and the need to avoid risks. Predator movement patterns and environmental features create different levels of perceived predation risk by prey, which may respond by altering their own movement and behaviour accordingly. Prey may strategically choose specific habitats, less reachable by predators, or shift their activity to times of the day when predators are less active.

This spatiotemporal variation in prey perception of predation risk across their home range is called the 'landscape of fear'. It is a prey's cognitive, mental map of how it perceives the risks of being predated.

Many factors contribute to risk or safety perception, including topography and vegetation structure. It also depends on the predator's hunting strategy (cursorial or ambush predation for wild predators;

Figure 2 ↓
Direct predation and predation risk can influence prey numbers and their spatiotemporal use of habitat.

different hunting modes, such as drive or approach hunting for humans) and the prey's escape tactics (for example, flee to steep, rocky habitat in the case of chamois).

In a human-dominated world, where all the ecosystem is affected by people, things are even more complex. A study conducted on more than 50 species, including herbivores, carnivores and omnivores, revealed that animal movements were reduced in areas with high human impact. In general, land use modification and expanding urban areas reduce natural habitats, fragmenting the landscape and altering both prey vulnerability and predators' hunting abilities. Wildlife species respond to human activities in complex ways, which may depend on the type, intensity and frequency of disturbance. On the other hand, some species appear to benefit from human environments: living in the surroundings of human settlements can provide food or protection (► FOCUS 3, page 13). Humans, thus, have the capacity to substantially reshape the landscapes of fear by adding complexity in space and time and at several scales.

Figure 3 ↓
In human-dominated landscapes, human activities affect both prey and predators.

How do the activities of hunters, hikers, livestock and livestock guarding dogs, as well as the presence of highway, roads, paths and buildings shape the relationships between predators and prey? What happens when, alongside wild predators like wolves or lynx, humans also are a significant threat to animals? Today, in our mountains, prey face the dual threat of being killed by natural predators and hunters, as well as the additional pressure of human disturbance. How do they manage to find food and other resources while avoiding these multiple risks?

Understanding how ecosystems work in human-dominated landscapes is crucial for effective management, long-term conservation, sustainable development of human activities and to enhance coexistence among humans, domestic animals, and wild animals in Europe's mountainous landscapes.

The LIFE WolfAlps EU project team worked in close partnership with hunters to address these knowledge gaps through a coordinated study across the Alps. The objective of the study was to quantify the responses of prey, particularly roe deer, to perceived predation risk by wolf and humans in space and time, while also accounting for the presence of alternative prey (domestic and wild) and alternative predators, in four different sites across the Alps.

Considering the complexity of studying human-wildlife-environment relationship, we used two main approaches that allow for an in-depth examination of different aspects:

- the spatial and temporal behavior of roe deer exposed to varying levels of predation risk and disturbance, in terms of hunting pressure, presence of wolves and other predators, and different levels of urbanization, using GPS data.
- comparison of camera trapping and GPS tracking to study the space use by red deer and species interactions.

In this booklet, we present the main results obtained during the LIFE WolfAlps EU project thanks to the international collaboration of research teams and the support of hunters in France, Italy and Slovenia.

FOCUS 3

Human shield

Human presence and activities do not only influence ungulate behaviour, but also predators. Large carnivores tend to avoid humans and human infrastructures in space and time. The "human shield hypothesis" predicts that prey might take advantage of the elusive behaviour of predators and use areas near human settlements and infrastructure to decrease the risk of encountering predators. Prey can therefore use areas in which humans are active as a strategy to minimise risk towards natural predators and even human hunters.

The four study areas

01 BAUGES MASSIF FRANCE

The Bauges National Hunting and Wildlife Reserve is located in the eastern part of the Bauges massif in the Savoie and Haute-Savoie departments in the northern French Alps. The Reserve is located within the Bauges Massif Natural Regional Park and covers 5214 hectares. The habitat is dominated by beech woods which cover roughly half the total area of the Reserve. Other habitat types that are well represented are alpine and subalpine limestone grasslands, vegetation of continental limestone cliffs, and subalpine thickets and tall grass communities. Sporadic wolf presence in the Bauges massif, particularly in the Reserve, has been intermittently observed since the early 2000s, peaking in 2008-2009 before declining in the 2010s. However, in 2019, clear signs of wolf presence were observed, and in summer 2021, reproduction was confirmed. Chamois, mouflons, roe deer and red deer live in the Reserve, and scientific research has been conducted there on this group of animals since 1985. Culling of wild ungulates is permitted in the Reserve under certain conditions. Chamois is the most widespread species, and therefore the most hunted, followed by mouflon, wild boar and roe and red deer. The five ungulate species are harvested in and around the Bauges reserve from August to February, chamois and mouflon being hunted by approach, whereas red deer, wild boar and roe deer are drive-hunted with dogs.

02

MARITIME ALPS ITALY

The Maritime Alps study area is a mountain area between 270 and 2300 m over 600 km2 wide in the Cuneo Province of the Piedmont region. The study area is centred in the Pesio Valley, but also encompasses parts of the Ellero and Vermenagna valleys, and lower altitude areas. Part of the study site lies within the Marguareis Natural Park (PNM) and part within the public hunting district CACN5. Forests cover more than half of the area. The region features a well-developed network of marked footpaths, including the southernmost section of the GTA, a long-distance hiking trail across the Alps. Mountain tourism is well developed, with three major ski resorts located in the study area. Farming and hunting are traditional activities in the valley.

The area roughly corresponds to the territory of the "Pesio Valley" wolf pack, the first wolf pack that arrived in western Alps by a natural recolonization process from central Italy. The first detection of wolves in the territory occurred in 1989 and since 1995-1996, wolf presence has been stable and well documented. Four species of wild ungulates populate the valley: roe and red deer, wild boar, chamois. Hunting activities are concentrated between late August and January: chamois are hunted by approach, wild boar mainly by drive hunts using dogs, and roe deer by "sit and wait" mode.

03

STELVIO NATIONAL PARK ITALY

The study area of Valfurva lies within the Stelvio National Park, in the Province of Sondrio, Central Italian Alps. The boundaries of the study area were chosen based on observations and GPS telemetry data on summer and winter distribution of red deer. The area extends over about 10,000 hectares, ranging from 1200 to 3000 m. a.s.l.; the climate is alpine continental. Five species of ungulates are present in Valfurva: red deer, chamois, ibex, roe deer and rarely wild boar. No hunting occurs within the Park boundaries, however culling of red deer is conducted to control deer density and numbers. Wolf presence is sporadic: on February 19, 2023, a wolf was found dead in Val Zebrù, a side valley of Valfurva. After that, a few events of wolf predation have occurred; however, there was no evidence of stable wolf presence during the study period.

04

JELOVICA PLATEAU SLOVENIA

The study area in Slovenia is located in the northwest of the country in the Julian Alps. The area is characterised by high peaks and steep slopes, culminating at 2864 m above sea level on Mount Triglav. There are also two alpine plateaus, Jelovica and Pokljuka. The area of the Jelovica wolf pack and GPS-monitored roe deer covers the Jelovica plateau and extends westwards towards the Julian Alps at an altitude of 440 to 2086 m a.s.l. Most of this area is covered by forests. Urbanisation of the area is very low and mainly present in the alpine and pre-alpine valleys surrounding the plateau. The Jelovica wolf pack has been reproducing in this area since 2019. Five ungulate species occur in this study area: roe deer, red deer, wild boar, chamois and mouflon. Different hunting seasons usually apply to the different ungulate species and their sex and age classes, but most hunting seasons in Slovenia are open between August/September and December/January. Roe deer are usually hunted by waiting on fixed elevated stands or by approach, and it is usually the case for chamois and mouflon. Red deer and wild boar can be hunted in all three ways (waiting on fixed elevated stands, approach and drive hunts with dogs), but driven hunts are most common in the fall and winter, while single hunts for red deer stags are most common in the rutting season in September and October.

Roe deer and red deer captures

ROE DEER CAPTURES

Roe deer were captured using box and cage traps in the Bauges, Pesio Valley and Jelovica study areas. This method is considered the safest one, and it is commonly used in areas with severe winters, such as the Alps. Box traps are wooden boxes with automatically-triggered sliding doors on the front side and a feeder for baiting on the opposite side. Three sides of the box trap are fixed, while at the entrance, the sliding door is connected to the feeder by a triggering mechanism. Traps are baited with food or salt to attract roe deer to the location and encourage them to enter. When an animal enters the trap and touches the fishing rope when eating from the feeder, it triggers the mechanism that releases the sliding door, which falls down behind the animal. In Slovenia and Italy, roe deer were captured over the three years of the project, while in France we used GPS data from captured animals obtained over 15 years in the scope of the long-term monitoring conducted in the area. Thanks to the collaboration of local hunters, traps were placed in sites regularly used by roe deer and easily reachable even with snow. Camera traps allowed us to record roe deer visits to the box traps and their behaviour.

Transport and placement of a roe deer trap in the Valle Pesio study area, Italy.

left to right →
Placement of a box trap in the Jelovica Plateau, SLovenia.

Capture site in Valle Pesio, Italy.

left to right →
A roe deer approaching the box trap on Jelovica Plateau in Slovenia. The surroundings of the box traps were surveilled by camera traps.

A roe deer enters a deactivated box trap in Bauges, France.

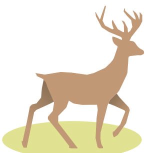
left to right →
SIgn indicating the roe deer capture site in Valle Pesio, Italy.

Night time capture in Valle Pesio, Italy.

left to right →
Roe deer, captured on Jelovica plateau in Slovenia and being equipped with a telemetry collar.

Release of a GPS-collared roe deer on Jelovica plateau in Slovenia.

When the sliding door of a box trap is closed, an alarm signal is sent to the capture team. One operator reaches the capture site to verify the actual event at the trap. If a species other than roe deer was caught, the operator releases it and activates the box trap again. If a roe deer was captured, the rest of the team is informed and reaches the site as soon as possible. The captured roe deer is extracted from the trap, blindfolded with a face mask to help it calm down and physically immobilized (no narcotics are used). Handling and marking of the individual is always carried out in silence and quickly to not add additional stress to the animal. A total of 39 roe deer were captured and collared in the framework of the LIFE WolfAlps EU project in Italy and Slovenia.
In France, 35 roe deer were caught over 15 years preceding this study.



RED DEER CAPTURES

In the Valfurva study area in Stelvio National Park, the ungulate species studied was red deer. Red deer were captured using two methods: corrals and telenarcosis of free-ranging individuals. Corrals are large wooden enclosures, but use a similar triggering mechanism as box traps for roe deer. The enclosures are baited with hay to attract red deer to enter. In Valfurva there are 4 corral sites that have been used to capture red deer since 2011. Captures take place during winter.
The corrals are activated at dusk and remain active all night until dawn, when the capture team, including a veterinarian, arrives on site. Red deer are then sedated to be marked and measured. Overall, between 2019 and 2023, 20 red deer were captured.

left to right →

The dart used to sedate deer.

A male red deer inside a corral is going to fall asleep, since it has been darted with a sedative.

left to right →

Equipping a male red deer with a GPS radio-collar.

A young male red deer captured and marked with a GPS radio-collar and ear tags.

→

Release of a marked female red deer.

Camera trapping

Camera traps were used to observe the simultaneous presence of different animal species (wild, domestic, human) in space and timein space and time to better understand how these species interact with each other. Camera traps were positioned according to a thorough monitoring design, which ensured that they were evenly scattered across the study area. To achieve this, the study area was divided into square cells with 1.5 km sides to create a grid, and one camera trap was placed in each of these squares.
Camera traps were placed on trees or wooden poles at a standard height of 50 cm from the ground, and no baits were used for attracting animals. The data collection process helps in estimating the 'occupancy,' which refers to the probability of a species being present in a specific area. This estimation takes into account various environmental characteristics, the presence of wolves, ungulates and human presence and activities. Additionally, it is also possible to estimate "contactability", which is the probability of successfully capturing a photo of a particular species at a specific site.
Camera trapping was conducted in Stelvio National Park, Bauges and Pesio Valley study areas. A total of 188 camera traps were placed: 60 in Bauges, 78 in Pesio Valley and 50 in Valfurva.

A camera trap is placed on a tree in Valfurva, Stelvio National Park.

left to right →
Red deer photographed by a camera trap in Stelvio National Park.

Roe deer in in Stelvio National Park.

left to right →
A wolf captured by a camera trap in Bauges.

A mouflon in the Bauges.

left to right →
A chamois in Pesio Valley.

Roe deer photo-trapped in Pesio Valley.

What drives roe deer use of habitat under different 'Landscapes of Fear'?

To answer this question in our study, we analysed GPS data from 45-collared roe deer across three of the four alpine study areas. We wanted to understand how roe deer respond at different contexts of risk generated by humans and wolves. The three study areas had varying levels of wolf density —high (Pesio valley in Italy), moderate (Jelovica plateau in Slovenia), and low or absent (Les Bauges in France)— as well as sites with high and low levels of hunting pressure and extent of urbanisation. By comparing these different landscapes, we aimed to understand how roe deer adjust their use of space in response to both wild predators and human hunting, as well as human disturbance. We analysed roe deer spatial data, obtained from telemetry collars, in the period from September to December, when the hunting season was open in all three study areas.

► see Figure 4

The results of our study revealed that roe deer adjust their behaviour depending on the time of day, the level of human disturbance and also on the context of risk in which they live: we found different spatial behaviour in the three study areas, which differ in hunting pressure, wolf presence and urbanisation.

As a general pattern, roe deer stayed in the forest and rugged areas during the day, while using more open and flat areas at night. They tended to avoid areas with a higher risk of being hunted, but we found great variability in their responses to hunting. At night, when hunting activity was absent, these high-risk areas were used often by roe deer.

One of the most interesting results we found is that roe deer approached buildings as protection against both hunters and wolves, as predicted by the *"human shield"* hypothesis (▶ FOCUS 3, page 13). During the day, especially in areas with higher risk of hunting, roe deer tended to stay closer to buildings and forests. At night, when wolves are usually more active, roe deer moved closer to buildings only in less urbanised areas, possibly to avoid wolf predation or find food in areas with lower levels of human disturbance. In more urbanised areas, such as villages, they preferred to stay close to the forests, likely seeking shelter from human activity.

Our results provide the first evidence that roe deer use human settlements both to avoid hunters during the day and possibly wild predators at night, demonstrating their ability to adapt to different types of risk depending on the context and time of the day.

Figure 4 ↓ The three study areas in France, Italy and Slovenia, in which we compared how roe deer use their space.

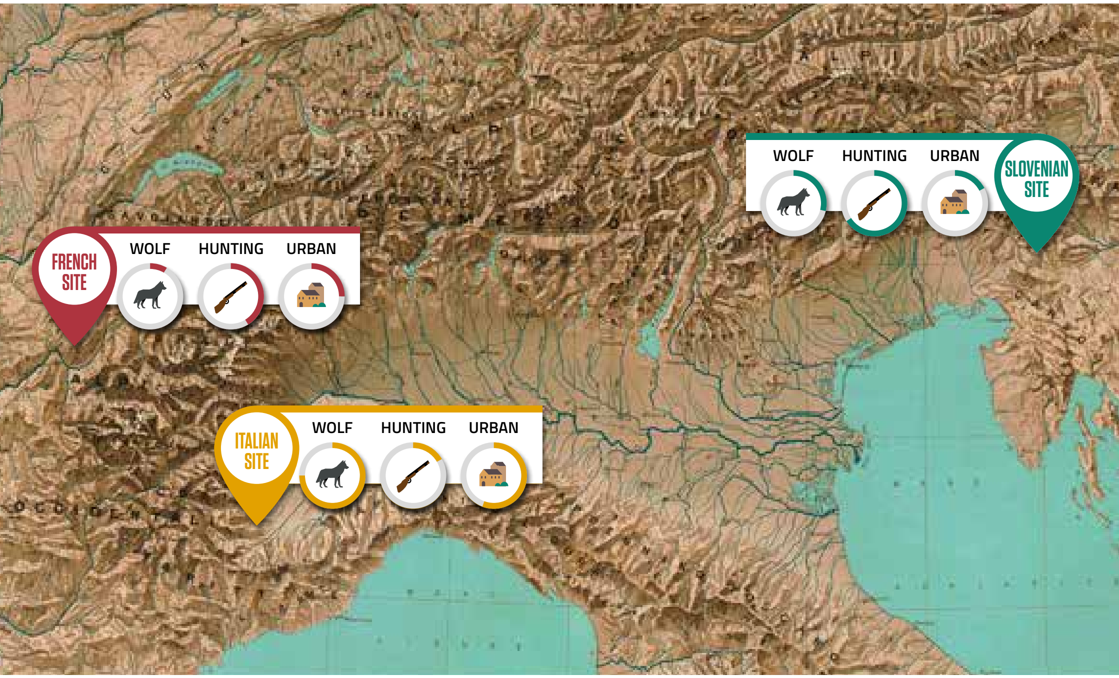


Figure 5 ↑ During the day, roe deer choose forested areas. Even when they go in open areas, the distance from the forest is short. Instead, they use open areas at night.

In general we found that roe deer behave differently based on the context of risk in which they live. In other words, they make decisions based on what is available—it's like saying: "*do what you can with what you have*".

By analysing the roe deer's responses in each study area, we found great variability among the sites. In Italy, where wolf density was higher, roe deer showed a stronger avoidance of high-risk hunting areas both during the day and at night, when the hunting activities were absent. We could interpret this response as a consequence of the cumulative pressures from both humans and wolves in this study area. In other regions, like in the study area in France, where wolf presence was low or sporadic, but hunting pressure was high, the space use of roe deer was likely more influenced by food availability and forest cover than by predation risk. In Slovenia, on the other hand, where wolf presence was only of recent establishment in comparison to Italy, we found exactly what we expected in our predictions related to hunting: during the day, roe deer avoided areas with high hunting risk, but selected such areas at night. This could be due to the fact that areas with higher hunting risk were not necessarily risky in terms of natural predators (wolves and lynx). As a result, roe deer may feel safer and be more active in these areas at night.

Figure 6 ➔
During the night roe deer moved closer to buildings, but only if these are sparse settlements, as they avoid larger ones. Staying closer to buildings they try to avoid wolf predation, as predicted by the human shield hypothesis (see page 13).

Figure 7 ➔
In areas with higher hunting activities, roe deer use areas closer to settlements, as well as forested areas.

Our results highlight diverse scales of roe deer anti-predatory behaviour influenced by natural and anthropogenic factors and the importance of understanding how wildlife interacts with both natural and human-driven risks. Roe deer has an incredible adaptability. They modify their behaviour to cope with the overlapping threats posed by both human activities and natural predators. This ability to adjust their responses likely contributes to the success of roe deer in human-dominated landscapes.

Where do prey live?

A comparison of data obtained with camera traps and GPS collars to understand red deer habitat preference

Understanding how wild animals are distributed in a given environment and the factors associated with these distributions is a central topic for wildlife management and conservation. Wild animals do not distribute themselves randomly; each species is adapted to a range of environmental characteristics that might vary in different populations and in different seasons, for example: forage availability and quality, presence of shelters, terrain ruggedness, and climate.
The study of habitat preferences, therefore, expresses the connection between a species and the environmental context in which it lives and allows us to understand how landscape features determine a species' spatial distribution.
Species distributions are developed based on "occurrence records," which catalogue locations in which animals were observed over a defined period of time. These occurrence records can be collected in different ways: through direct sightings, collection of signs of presence or the use of radio collars. GPS locations obtained through radio-collaring species are arguably the most reliable method, but the use of this technology is limited by the costs of the equipment, the number of individuals that can be captured and fitted with GPS collars, and the battery life of these collars.

Camera traps provide a non-invasive approach for both single-species and multi-species analyses and offer the possibility of long-term sampling over space and time.

Can data obtained through camera trapping provide a reliable (and cost-effective) alternative to radio-collaring in habitat preference and wildlife distribution studies? And how comparable are the two methods?

In the Stelvio National Park, we conducted a study to assess the reliability and accuracy of camera trap data in predicting red deer habitat preference compared to the use of GPS collars. In the study area of Valfurva, we deployed 50 camera traps for five consecutive years, from 2019 to 2023, from May to October. We captured a total of 183,487 images of red deer. Additionally, 23 red deer (15 females and 8 males) were fitted with GPS collars, providing nearly 55,000 deer locations.

We evaluated deer habitat preference using both methods, and the comparison of the results suggests that camera traps can be used to predict deer distribution in relation to environmental features. This was especially true for female red deer, which were well represented in both camera trap images and GPS collaring data. These findings indicate that camera traps can be used as a viable alternative to GPS collars, as long as the sampling area is wide enough to detect the species, and an appropriate number of camera traps are deployed for an adequate sampling period.

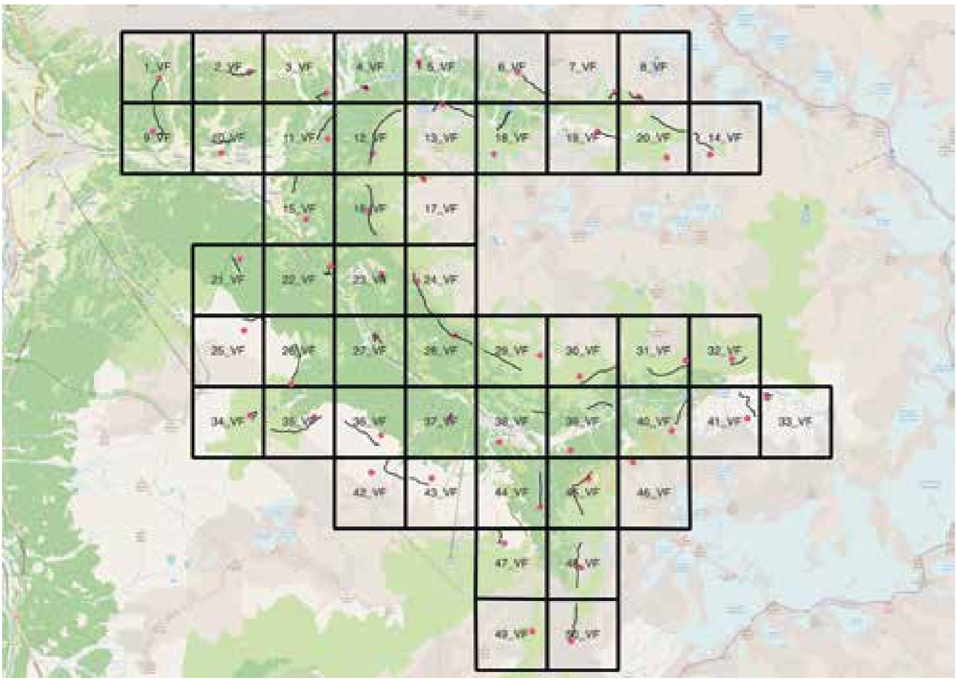


Figure 8 ↓
Map of the location of 50 camera traps used in Valfurva to estimate red deer distribution.

FOCUS 4

"Jelovica" wolf pack and interactions with the GPS-collared roe deer in the Slovenian study area

In the Slovenian study area, thanks to the simultaneous presence of GPS-collared wolves and roe deer on the Jelovica plateau, it was possible to observe some interactions between the two species using GPS-tracking data.

Three sub-adult wolves from the Jelovica pack were equipped with a GPS collar in three capture seasons with the purpose of tracking their movements: a male wolf Jelko (2020/2021), a male wolf Mojmir (2021/2022) and a female wolf Neža (2022/23). Wolf traps (soft-catch leg holds) were buried on the side of the road with a lure (wolf scat) placed next to it. The traps needed to be set very carefully, without leaving any human scent behind and with no trap components sticking out of the soil. The trigger was pre-set to the appropriate weight to reduce the possibility of capturing smaller animals, like foxes or badgers. The traps were equipped with alarm systems (GSM or satellite) and monitored by automatic cameras with remote transmission.

The captured wolf could pull the trap out of the soil with a chained anchor and drag it to a perceived safer place in the vicinity in the forest, where it could wait for the arrival of the capture team more calmly.

Capture site with a wolf trap buried on the side of the road. Left: inactive wolf trap (covered with a rock); right: active trap hidden underneath the gravel.

Sedation of a captured wolf in the Slovenian study area.

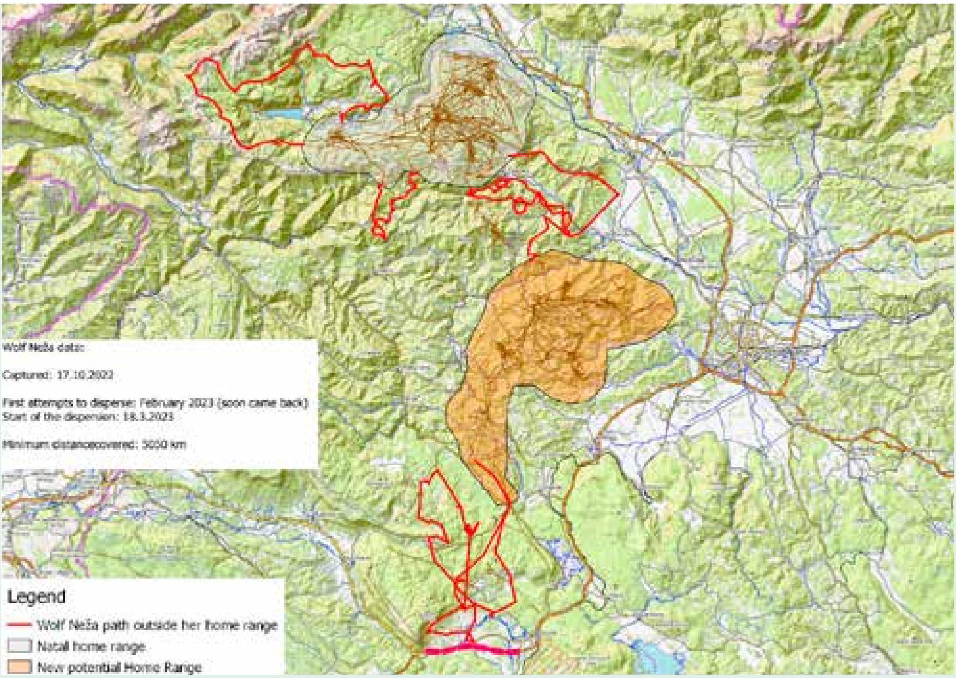


Figure 9 ↑ Movement of a GPS-tracked female wolf Neža from the "Jelovica" natal pack (top of the figure) in the period from October 2022 to December 2023.

Thanks to GPS data we could track the dispersal process of two of the monitored wolves in the area, Jelko and Neža. Jelko, born in 2020, went into dispersal towards Italy in 2021 and settled in the wider area of Resia, around 75 km away from his natal pack area. Unfortunately, he was killed in a traffic accident on a fast-lane road at the start of the reproductive season in February 2022.

A female wolf Neža, born in the "Jelovica" litter of 2022, undertook a dispersal process with several explorations and had returned before she finally dispersed away from the natal pack. She started her explorations in February 2023, taking three excursions, each several days long, in different directions (▶ Figure 9). In March 2023 she finally dispersed south, all the way to the Ljubljana – Koper highway, which she failed to cross, and then returned to the pre-alpine area, where she settled in a previously wolf-unoccupied area.

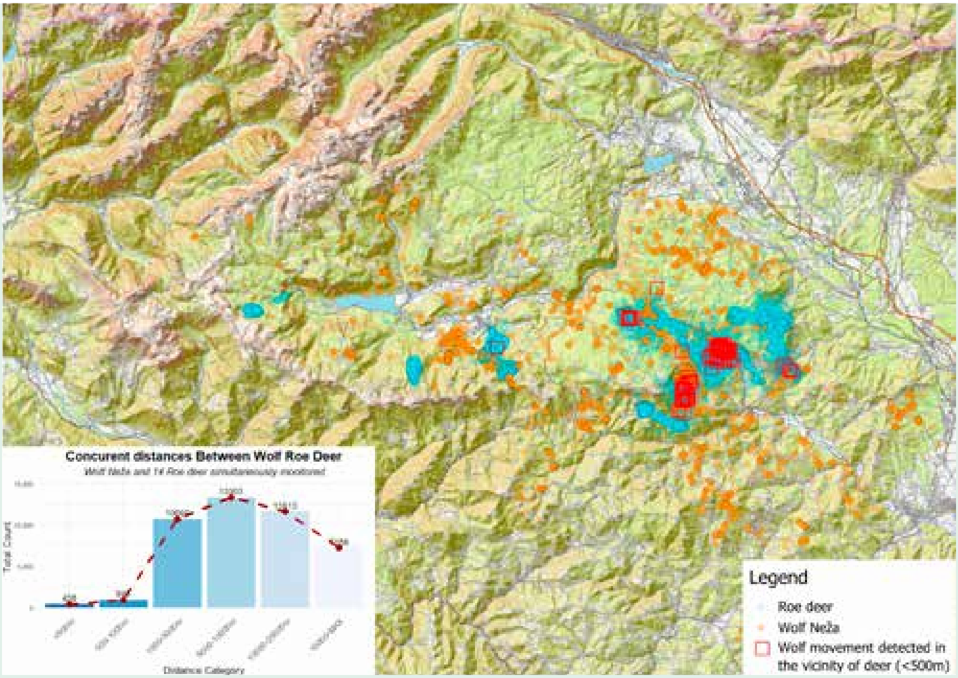


Figure 10 ↑
GPS locations of telemetry-collared wolf Neža from the "Jelovica" pack (orange points) and 14 collared roe deer (blue points), as well as locations (red squares), when the wolf was less than 500 m away from a roe deer.

She was monitored until December 2023. In one year of monitoring, she travelled a minimum of 5350 km, considering only linear distances between the GPS points obtained from the collar.

When exploring the movement of GPS-tracked wolf Neža and 14 roe deer simultaneously, we wanted to find out how many times the wolf actually came into the proximity of GPS-collared roe deer.
During the monitoring period, there were 438 occasions when the wolf came within 500 m of the GPS-tracked roe deer and 943 occasions within 500 - 1000 m of distance. There were 13 occasions when the wolf came within 50 m of the roe deer. No predation events were detected during these occasions when the GPS-collared wolf approached the roe deer. These data illustrate the fact that only a minor share of wolf approaches to roe deer result in actual predation and that it's not so easy for the wolf to kill its prey.

Conclusion

Take-home messages

1 ▪ Roe deer adapt their use of habitat depending on the context of risk generated by predators and human hunting, and the level of urbanisation in each area, with a strong impact of anthropogenic infrastructures. We found that roe deer used buildings as a human shield not only against wild predators, but also against hunters.

2 ▪ Our study provides a first insight into the cumulative effect of wolves, urbanisation and human activities on roe deer, a topic which should be further studied and taken into account when determining hunting bags and other aspects of hunting.

3 ▪ Using both GPS collars and camera traps, we found similar results on red deer habitat selection. Camera traps proved to be an effective and non-invasive alternative to GPS collars. With a well-distributed set-up, they could offer similar insights into deer habitat preferences while being more cost-effective.

Understanding the complexity of ecosystems, further enhanced by human activities, requires a participatory approach involving all stakeholders.

This study and Action C3 of the LIFE WolfAlps EU project represent an initial step in building a network of partners working together to enhance our understanding of how animals like roe deer and red deer live within a human-dominated world. The goal is to achieve greater sustainability in our activities and foster coexistence with the natural world, of which humans are only one part.

Acknowledgements

This work was made possible thanks to the collaboration of many people, whom we wish to thank for their precious work

Aree protette Alpi Marittime

Davide Sigaudo, Laura Martinelli, Dario Airaudo, Francesco Belghazi, Marta Bertolino, Alessandro Bolfo, Maria Virginia Boiani, Andrea Cappatti, Valentina Carlotti, Luca Fardone, Francesca Gaydou, Matteo Gatti, Michela Macario, Aarianna Menzano, Filippo Parentela, Francesca Rolle, Annabelle Thierry, The Hunting district CACN5, the park-rangers and all the staff of Aree Protette Alpi Marittime.

Slovenian Forest Service & University of Ljubljana

Aleš Pičulin, Andrej Rot, Franc Kljun, Janina Vovk, Miha Krofel, Benedict Gehr, Sandro Nicoloso, Federico Ossi, Lan Hočevar, Matija Stergar, Teresa Oliveira, Andraž Valcl, Groga Čenčič, Mohor Habjan, Julij Benedičič, Simon Tolar, Matjaž Lušina, Peter Bevk, Branko Tavčar, Štefan Trojar, Miran Hafner, Marko Brenkuš, Miha Šubic, Bojan Hafner, Milan Hafnar, Robert Kozjek, Boštjan Pikon, Tom Ravnik, Gregor Hodnik, Primož Pikon, Jožef Trošt, Janez Pretnar, Miloš Ferjan, Peter Benedik, Miha Marolt, Jernej Legat, Andrej Varl, Florijan Tišler, Franci Tišler, Miha Marolt, Peter Belhar, Urša Fležar, Branko Gartner, Maja Sever, Jernej Javornik, Matej Bartol, Pavel Kvapil.

ERSAF LOMBARDIA e Parco Nazionale dello Stelvio Lombardia

Endrich Silvestri, Alessandro Gugiatti, Elisa Iacona, Valerio Donini, Matteo Nava, Lucrezia Lorenzetti, thesis students and interns who helped with data collection, Carabinieri Forestali Reparto Parco Nazionale dello Stelvio, Fabrizio Cappa, Stefano Neè, Lucia Ratti.

Office français de la biodiversité

Carla Bassi, Morgan Dif-Turgis, Nolwenn Drouet-Hoguet, Christophe Duchamp, Jérôme Boyer, Mathieu Garel, William Gaudry, Eric Marboutin, Mathieu Beurier, Thibaut Amblard, Carole Toïgo and other OFB staff in Bauges, as well as members of the “GIC des Bauges” hunter group and personnel from the Bauges Natural Regional Park and the French Forestry Office (ONF).

LIFE WOLFALPS EU

NATURA 2000

The **LIFE WOLFALPS EU** project works to improve coexistence between the wolfand the people who live and work in the Alps and the Ligurian-Piedmontese Apennines by building and implementing shared solutions together with stakeholders to ensure the long-term conservation of the wolf in the Alps and along the Apennine corridor.

LIFE WOLFALPS EU operates throughout the Alps and the Ligurian-Piedmontese Apennines, involving twenty Italian, Slovenian, French and Austrian partners and dozens of Institutions and associations that support the project.

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This booklet was realized with the financial contribution of the LIFE Programme, financial instrument of the European Union.
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Co-Financers

Republika Slovenija Ministrstvo za okolje in prostor · Fondazione Capellino · Fondation Prince Albert II de Monaco · Préfet de la Région Auvergne-Rhône-Alpes · Federal Ministry Republic of Austria Climate Action, Environment, Energy, Mobility, Innovation and Technology · Fondation François Sommer