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About the IUGB

The International Union of Game Biologists (IUGB) is a non-profit organization with international membership. It has its legal domicile in Cernier, Switzerland. The organization aims to promote knowledge about game biology and related fields of study such as animal population management and habitat conservation. Its actual bylaws have been accepted in Moscow, in 2009.

The aims are to increase the knowledge about game species and any other areas related to wildlife, such as wise use of animal populations and the conservation of their habitats. The conference is taking place every two years since 1954. Over time, IUGB has become a platform that allows networking among its Members.

The IUGB objectives are as follows:

- An international congress every two years.
- Promote the concept of sustainable use of wildlife resources.
- Stimulate research and international technical cooperation in the elaboration of new models of development and management of renewable resources, integrating wildlife conservation, wise use and economic decisions.
- Promote awareness and recognition of wildlife values.
- Support and advances high standards of education and professional performance in the field of wildlife management.
- Contribute to the solidarity amongst its Members.
- Is committed to the protection of wild animals and the conservation of species.
- Exchanges information and encourages other forms of collaboration between this and other associations in allied scientific disciplines.

To achieve its objectives, the IUGB shall:

- Organise, co-sponsor and promote scientific meetings, training seminars, excursions and similar events.
- Undertake the publication of the results of its scientific meetings, encourage the submission of scientific articles to peer-reviewed journals, etc.
- Issue international directors of institutions and bodies providing education facilities supporting the aims and objectives of IUGB.
- Encourage student participation through the presentation of awards for scientific contributions.
- Establish close relationships with governmental agencies, intergovernmental bodies and organizations of the private sector concerned with regulatory matters related to wildlife.
- Stand up for the concerns and professional interests of its associates and participants.
- Use any other means necessary to achieve the objectives.

ABSTRACTS OF THE 35TH IUGB CONGRESS

Elaboration of a monitoring tool for ungulates to assist decision making for their hunting management at the scale of a vast geographical entity. The case of the Lot-et-Garonne Department (South-West France)

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Under French law, the Hunters Federations (FDC) of each of the over 90 administrative *Departments* of that country are currently competent for monitoring the abundance of Ungulates, for assessing their impact on rural economic activities, for compensating for damages they may cause to agriculture as well as for elaborating public hunting policies for the management of these species. For an extended period, the government shared these missions and the administration of hunting by a state agency, the ONFCS (Office national de la chasse et de la faune sauvage devenu aujourd'hui OFB) and by the FDC's. More recently, the latter's role was, however, considerably expanded due to an optimisation process among public services and the rationalisation of human resources within the French administration.

The territorial entities of the Departments covered by the FDC's are vast – in the case of Lot-et-Garonne 5.360 km². Consequently, the game populations can be high, and the need to keep these under control is complicated by the fact that this is exclusively done through hunting, in a general context of shrinking numbers and ageing of hunters. The FDC's are also confronted with the need to reduce staff, and it is, therefore, with a limited number of technical agents they must undertake the monitoring of Ungulates and the assessment of hunting efficiency for adapted management policies.

In the Lot-et-Garonne, three species are concerned: Red deer (*Cervus elaphus*), Roe deer (*Capreolus capreolus*) and Wild boar (*Sus scrofa*). Current investigation methodologies enabling to measure variations in population abundance, dynamics and interactions with their environment are reliable but costly in terms of work time. The FDC has therefore opted for focusing its resources above all on the animation of hunters' societies, the human dimension being essential for the efficiency of regulating the Ungulate population through hunting. The impact on economic and human activities is only assessed in the case of agriculture damage.

The knowledge of bag data and the evaluation of hunting effort, and the efficiency of hunting methods are significant parameters. In these domains, not much work has led to defining analytical and monitoring tools enabling the production of calibrated indicators. Based on a set of markers for assessing the situation and its evolution over time, a monitoring dashboard is

lacking. Also needed to assist policy decisions is a tool that is simple to operate and to understand, as well as sufficiently comprehensive to rely on the conclusions it provides. In the frame of a university degree "*Master Agronomie - Environnement- Territoires - Paysage et Forêt*" at the University of Vandœuvre-Lès-Nancy (France), the available data were analysed and statistically tested to obtain simple indicators for each species. The goal in the first phase was to characterise for each species the impact on human activities, the abundance, the efficiency of hunting and the evolution of the system over time, and in a second phase, the concordance between the hunting management in place and the objectives defined by the public policies. The flaws and limits of the method were considered, among others linked to the conversion of quantitative data into qualitative indicators, which are inevitably biased.

Impact of GI.1 and GI.2 rabbit haemorrhagic disease variants on wild rabbit populations based on Spanish national hunting bag

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Purpose/Objective: Rabbit haemorrhagic disease virus (RHDV) is a pathogen causing infectious disease in European wild rabbits. Its first outbreak (from hereon, GI.1) in Spain was in June 1988. A novel RHDV variant (from here on GI.2) was discovered in France in 2010, followed by Spain in October 2011. While local evidence exists between the spread of this pathogen and the sharp decline over the last 50 years of wild rabbits' populations, there is a lack of information at a broader geographical scale. In Spain, the number of hunted pieces (hunting bags) must be declared by law and are publicly available from the yearbooks published by the National Institute of Statistics and the website of the Ministry of Agriculture and Fisheries, Food and Environment. We analysed the impact of the two RHDV variants in Spanish wild rabbit populations using an index of rabbit abundance extrapolated by the number of specimens killed by licensed hunters (data from country-wide hunting bags).

Material/methods: Hunting bags data were obtaining by the annual yearbooks published (since 1970) by the National Institute of Statistics (INE) of the Ministry of Economy, Industry and Competitiveness. As an additional source of information, we gathered data from the yearbooks published on the Ministry of Agriculture and Fisheries, Food and Environment (MAPAMA) website. We used R to test whether an index of abundance obtained by the hunting bags data decreased after the emergence of each RHDV variant.

Results: Our findings reveal a significant decrease in rabbit abundance across the country following the GI.1 outbreak but a slight increase following the GI.2 outbreak at the national level. However, rabbit abundance has dropped in some Spanish regions following the GI.2 outbreak, though not to the same extent as following the GI.1 outbreak.

Conclusion: Hunting bags can provide a general abundance index that may prove helpful to detect population trends and be especially relevant for the surveillance and control of emerging diseases. While the negative effect of GI.1 on rabbit population dynamics is evident, it is not so for GI.2, especially at the national scale. We contend that the negative effect of GI.2 on rabbits' populations at the national scale might be hidden by the sharp increase of rabbits' density in some regions.

Brown Hare (*Lepus europaeus* Pallas, 1778) current status: Recovery Plan and Challenges

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Keywords: Brown hare, status, threats, conservation, delineation, Action Plan

Once abundant and widespread game species in Lithuania in the 1960s and the following 1970s, the Brown hare (*Lepus europaeus* Pallas, 1778) population decreased 3-4 times. Within the current decline, the population dynamics have become unusual. The main reason for the decline of the hare population was its natural fluctuation combined with the drastic impact of human factors. Then the influence of the natural factors increases, including continuous climate changes. The growing concern regarding the status of the Brown hare is reflected in mass media, emphasizing a decrease in hunting bags and imperfect count. Since 2003 the Institute of Forestry LAMMC performs the comprehensive and continuous monitoring of game species, including Brown hare. The study was conducted using the integrated method of pellet group count and transect-based sampling (sampling unit 50x2) within the monitoring network. Simultaneously, the long-term official statistics on the game count and harvesting was used. The study results show overall deterioration in the conservation status of local populations. The species status depends not only on feeding habitat quality but also on the habitat conservation status. The main threats identified are agricultural intensification (critical state), a decrease of the optimal feeding habitats, carnivores, diseases and disturbance (considerable), the direct impact of humans (hunting, poaching etc. (occurs locally), traffic accidents (occurs locally). The Species Action Plan was prepared. We provide information about the status, ecology, threats and needed conservation measures for Brown Hare and list the critical actions required to improve its status in Lithuania. The Plan's goals and measures encompass improving foraging and hiding conditions in agricultural lands and forest habitats, developing agroforestry and protecting hares during the farming cycle. The increasing role of forests was emphasized. The actions of habitat protection are based on the delineation of the whole country for species. The specific measures for each regional hunting ground unit were recommended.

The spread of the golden jackal (*Canis aureus*) in Hungary

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Objective: The golden jackal (*Canis aureus*) is a native mesocarnivore in the Northern Hemisphere that has shown a rapid expansion in Europe in the last few decades. Consequently, the concern for the consequences began to grow. It is essential to understand the underlying causes and the extent of the expansion to develop human-carnivore mitigation strategies and implement effective management tactics. This research takes a quantitative approach for modelling the spread of the species in Hungary in both space and time. In this study I aim to answer 1) how large the annual increase in the population size/hunting bag was of the golden jackal in Hungary in the last 25 years; 2) how large the annual increase in the range of the species was in the country during this period; 3) if there was a change in population density, if yes, then how much? Lastly, 4) if the spatial rate of increase during this period changed, and if yes, how? The goal is to provide a picture of the status of the species throughout the years and make predictions for the future on which to base future management plans.

Material and methods: Official hunting bag data of the National Game Management Database has been used from 1995, which are obtained from Game Management Units (GMU) in Hungary. As GMUs change in size and numbers over time, depending on changes in legislation and/or land ownership, new border drawings can take place either regularly or unexpectedly. Therefore, to prevent bias in space and overcome the problems of changing GMUs, the UTM grid system has also been used. Based on this hunting bag data, temporal and spatial analysis based on the UTM grid system and the GMUs were done.

Results: The results show an exponential growth in the hunting bag since 1995, and a strong increase in the occupied area, although with a slight deceleration in the last few years. The annual increase in occupied areas (km²) shows a logistic model, where a difference can be noticed between the first half of the period (1995-2006) and the second half (2007-2019). The golden jackal spread with an average speed of 536,9 km²/year (UTM) and 450,8 km²/year (GMU) in the first period, and 5581,3 km²/year (UTM) and 4298,2 km²/year (GMU) in the second period. The spatial analysis shows that the spatial rate of increase is in the range of 15-25% of occupied area per year. The annual increase in occupied UTM grid cells and GMUs show that the expansion of the golden jackal has passed its maximum and the annual increase is decreasing. Moreover, the numbers of occupied UTM grid cells and GMUs, and the occupied area sizes have grown at roughly the same rate.

Conclusion: In the upcoming years, we might face a further decrease in population growth but it is essential to keep monitoring and managing the golden jackal populations according to an action plan that includes control measures.

Using data from collective hunts to estimate the wild boar (*Sus scrofa*) population density in north-eastern Poland

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Keywords: collective hunts, driving census, harvest success, harvest rate, Poland, population density, rate of increase, *Sus scrofa*

The spread of African swine fever through the wild boar population has caused major losses in the pig industry. Therefore, to decrease the population density of wild boar in Poland, the culling of these animals has been dramatically increased. However, the effect of depopulation is unknown because no methods could be used throughout the country to estimate the number of wild boar. Thus, an attempt was made to estimate the number of wild boars using data from collective hunts during two hunting seasons. The forested area of 21 hunting districts (351.5 km²) was divided into five sampling inventory blocks (SIBs), which were used for the statistical analysis of the population density, the harvest rate and results of collective hunts. The average population density obtained by a driving census amounted to 8.19±1.12 and 10.09 ± 1.06 ($\bar{x}\pm SE$), animals/ km², which indicates that 2,879 and 3,547 wild boar were living in the study area in 2012/13 and 2013/14 seasons, respectively. The number of wild boars bagged per one hunting plot was adopted as the harvest success index (HBI). In SIBs, the HBI value fluctuated in the range of 0.55 to 1.87 individuals/hunting plot, and the population density ranged from 6.46 to 12.18 wild boars/km². The non-linear regression showed a positive relationship between the HBI index and the population density. The discussion covers the possibility of using collective hunts to estimate the number of wild boars in Poland and in the European Union.

Game management affecting population structure, and hence male-male competition for mates, also influence antler development in red deer

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Theory predicts that the plastic expression of sex traits should be modulated not only by their production costs but also by the benefits derived from the presence of rivals and mates, yet there is a lack of evidence for an adaptive response of sex-trait expression to the social environment. We studied antler size, a costly and plastic sex trait, and tooth wear, a feature related to food intake and longevity, in over 4,000 male Iberian red deer (*Cervus elaphus hispanicus*) from 56 wild populations characterized by two contrasting management practices that affect male age structure and adult sex-ratio. Therefore, these populations exhibit high and low levels of male-male competition for mating opportunities. We hypothesized that males under conditions of low intra-sexual competition would develop smaller antlers, after controlling for body size and age, than males under conditions of high intra-sexual competition, thus reducing energy demands (i.e., reducing intake and food comminution), and consequently, leading to less tooth wear and a concomitant longer potential lifespan. Our results supported these predictions. To reject possible uncontrolled factors that may have occurred in the wild populations, we carried out an experimental design on red deer in captivity, placing males in separate plots with females or with rival males during the period of antler growth. Males living with rivals grew larger antlers than males living in a female environment, which corroborates the results found in the wild populations. These results show, for the first time, the modulation of a sexual trait and its costs on longevity conditional upon the level of intra-sexual competition produced after game management.

Activity patterns of the community of large and mid-sized mammals in a not human-disturbed environment: A case study in the Gobi Desert, Mongolia

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The communities of large and medium-sized mammals commonly show complex patterns of ecological segregation at different levels, with a strong influence of limiting factors such as food resources, variety and suitability of available habitats, and species-specific behaviours and activity patterns. Understanding the relationships of these patterns among the community is essential for the conservation of the whole ecosystem. However, these networks are challenging to study nowadays since most of the world is already subjected to solid anthropic disturbances. That makes it difficult to investigate if the observed segregation patterns are due to natural

behaviours or human-induced ones. In this study, we analysed patterns of ecological segregation in a community of large and mid-sized mammals in the Great Gobi Desert, a remote arid area free from human disturbances. 10 sympatric species (*Equus hemionus* – Khulan; *Ursus arctos* – Brown bear; *Vulpes vulpes* – Red fox; *Lepus tolai* – Tolai hare; *Ovis ammon* – Argali; *Capra sibirica* – Siberian ibex; *Canis lupus* – Grey wolf; *Camelus ferus* – Bactrian camel; *Lynx lynx* – Eurasian lynx; *Panthera uncia* – Snow leopard; *Otocolobus manul* – Pallas's cat; *Gazella subgutturosa* – Goitered gazelle) were monitored around six waterholes through camera-trapping over two years, with 5 to 8 cameras being used at each of the sites. Circular statistics was the main tool used to analyse the data. Complex patterns of spatial, seasonal, and daily segregation were found. Among the 45 pairs of species, seasonal activity overlap was found just in 3 of them. Four species used the waterholes all year round, while others peaked their activity at different periods of the year. Overlap in daily activity was detected only in 6 pairs. Only the critically endangered Bactrian camel showed continuous daily activity. At the same time, the grey wolf had bimodal activity, argali and Siberian ibex were diurnal, and the others had nocturnal peaks at different hours. Spatial overlap was observed in another six pairs. Nevertheless, only one pair of species (snow leopard and Eurasian lynx) showed an overlap at two levels: seasonal and daily, and any pair showed overlap at the three studied levels. Thus, the results show complexity in using a critical resource in arid environments like waterholes, with ecological segregation at different levels among the studied species. These results are essential for understanding the biology of these species under natural conditions, free from human disturbance, which may help design conservation and management strategies.

Run to the hills! Reindeer (*Rangifer tarandus tarandus*) are safer from *Elaphostrongylus rangiferi* in the mountains

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Elaphostrongylus rangiferi is a nematode parasite in reindeer (*Rangifer tarandus*) which can cause considerable neurological damage and could affect the survival chances of the last European wild tundra reindeer. The parasite has terrestrial gastropods as intermediate hosts. Previous research has shown that the development of *E. rangiferi* inside gastropods is highly temperature-dependent, with faster development at higher temperatures. Additionally, the prevalence and infection intensity of *E. rangiferi* has previously been reported to be lower in reindeer grazing at high altitudes, but if this difference in infection rate is connected to gastropod densities is unknown.

We hypothesized that *E. rangiferi* prevalence and infection intensity could be explained by gastropod density in the reindeer's summer pasture. We estimated the gastropod density in different habitats within the summer pasture of the reindeer by visually searching 1x1m plots

for gastropods. Statistical prediction models were then made to map the predicted gastropod density in these areas. Prevalence and infection intensity of *E. rangiferi* in reindeer was estimated by collecting and analyzing fecal samples from two wild reindeer herds using the Baermann technique.

We showed that overall prevalence and infection intensity of *E. rangiferi* was significantly higher for reindeer that graze in areas with a high predicted gastropod density. These areas were mainly forested areas at low altitudes. The prevalence and infection intensity of *E. rangiferi* changed over time, with maximal output in fecal samples during early spring. These results provide a new dimension for understanding risk areas for *E. rangiferi* transmission. Furthermore, our study showed that the parasite was common in the wild reindeer population of Rondane, a population from which there was little prior information. In light of climate change, prevalence and density of this parasite in reindeer is expected to increase. This makes this parasite of increasing concern. Our findings, in combination with previous research, could be used by both reindeer herders and conservation managers for management and mitigation strategies of reindeer to prevent future outbreaks of *E. rangiferi*.

The importance of diversity [Keynote speech]

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What if biologists chose to study only one animal species in the world? Despite gaining tremendous understanding of the animal, this species would define our knowledge of all other species. Everything we identified about behaviour, diet, disease, evolution, habitat use, physiology, and reproduction would be focused through the lens of a single species. As biologists, we recognize this is a ridiculous proposition. Why then, should we be any less concerned about representing the full range of human qualities and attributes in our profession? A variety of genders, ethnicities, sexual orientations, perspectives, areas of expertise, and cultures leads to better science. Increases in productivity, creativity, and quality rise when women and underrepresented groups participate. Problem solving and collaboration among groups of people with diverse backgrounds and experiences leads to more innovative outcomes. Diverse groups of people raise different questions; questions drive science, and that moves science forward. For example, a Native American wildlife biologist who studied gene flow and population structure developed a non-invasive approach to sample DNA. She helped establish the practice of using faecal samples for DNA collection. Despite these and other examples, we struggle to ensure equal representation. We are drawn to people who are like us. What challenges do women and minorities face to entering and excelling in science? What are practical approaches to increase, recognize, and encourage contributions of diverse people into this profession? We must recognize our biases, create connections, act, and be allies to underrepresented groups. Those in leadership roles can recruit and train women and minorities, foster an open work culture, mentor, encourage cross-job communication and nonhierarchical

structures, make sure women and underrepresented minorities represent 15 to 30% of team members to gain critical mass. We drive science forward when “we” represents all of us.

Do wild boar driven hunts descend from the mountain peaks to the valleys?

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Keywords: Hunting grounds, Management, Population control, Wild boar

Driven hunts are the traditional method of wild boar hunting in Catalonia, Spain, and currently are the primary method for wild boar population control. Land use and wild boar distribution changes during the last 20 years may have also led to a variation in hunting grounds use and driven hunts distribution across the landscape. The objective of the present study is to evaluate changes in altitude of the areas where driven hunts are organised and the mean number of wild boar hunted in the different altitude ranges. Data from 1.036 drive hunts areas located in 6 study sites in central Catalonia were analysed. The hunting groups' accurate delimitation of each drive hunt perimeter was digitalised using QGIS. Detailed information about each drive hunt carried out in these areas, including the number of participants and dogs, number, sex and weight of individuals hunted and the number of individuals observed but not culled, was compiled in the database of the 'Catalan wild boar monitoring program'. This information allowed us to analyse the variation of driven hunts location and distribution of captures across years. The number of driven hunts and the annual mean number of wild boar hunted per hunt was calculated per each altitude range. Preliminary results show that the yearly mean altitude of the driven hunts carried out in each site has decreased across the years. Globally, the driven hunts' mean altitude has decreased from 689 m.a.s.l during the hunting season of 1999/2000 to 474 m.a.s.l in 2019/2020. Moreover, the altitude range where the highest mean of captures occurs has also decreased in most sites across the years. An increase in cultivated land and other humanised non-hunted areas offering food resources and refuges could be one of the reasons for the observed variations. These findings contribute to understanding wild boar distribution and hunting habits in Mediterranean areas during the last two decades. This knowledge is vital to improve the population control strategies and hunting planning and management. Analysing information about small scale hunting areas will also allow us to explore the factors that influence wild boar extraction potentials, such as land cover, habitat type, and distance to urban areas. We expect to obtain the results of these analyses during the following months.

Inter-specific differences in faecal nutrients in Saharan gazelles under the same feeding regime

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Digestive efficiency in wild ruminants may be affected by several environmental, individual and species-specific factors. The study of faecal nutrients is commonly used to understand these effects, assuming that faecal nitrogen and fibre contents reflect dietary ones. Recent studies have highlighted the relatively strong influence of several individual factors, like sex, age, weight or body condition. This paper focused on the inter-specific variability in faecal nutrients under a common feeding regime, using three captive populations of closely related gazelles as model species. Faecal samples from 193 individuals were analyzed through Near-Infrared Spectroscopy. Species, Sex and Age on faecal nitrogen and fibres (ADF, NDF) were studied. We found inter-specific differences in the faecal content of three studied nutrients. Cuvier's gazelle showed lower faecal nitrogen content suggesting higher digestive efficiency compared to Dorcas and dama gazelles. Sex and age also had a moderate effect, especially in faecal nitrogen, but these effects were not constant across the three studied species. On the contrary, faecal fibres were highly constant (i.e., dependent on diet quality). These results confirm that individual factors affecting faecal nutrients are also species-specific.

Chamois (*Rupicapra rupicapra*) and roe deer (*Capreolus capreolus*) in the Bavarian Alps – masters of adaptation with regard to energy supply

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(1) The condition of the Bavarian chamois populations has been a subject of heated debate for several years now, and the discussion is based on relatively little data on how the chamois population is faring here in Bavaria. Another inhabitant of the Bavarian Alps, whose nutrient and energy requirements are too little is known, is the roe deer.

(2) To get a comprehensive overview of how secure their energy supply is and how effectively they manage to adapt to the considerable seasonal fluctuations in conditions in the mountains,

we began collecting comprehensive data and samples for chamois and roe deer in the alpine region in Bavaria in 2017. The samples represent a cross-section taken over the year and both sexes and all age groups and habitat types. Among other parameters, the energy content and crude nutrient composition of the ingested food were determined, and the weight and volume of the rumens. Data from a total of 182 chamois and 205 roe deer were analysed.

(3) We were able to determine that adult chamois have an average energy density of 4400 kJ/kg DM (± 87.46) at their disposal in their habitat, with a minimum in winter and a maximum in spring. No significant difference between the different age groups or sexes was found. According to Hüppop (1995), the chamois has a basal metabolic rate of 2463 kJ/day and energy consumption of 9372 kJ/day in the open countryside. Given that the measured 4400 kJ/kg DM is a snapshot measurement representing a single filling of the rumen at a particular moment, and that chamois have 5-6 browsing periods each day (Hofmann & Müller 1983), the energy supply can be seen to be more than adequate at any period of the year. This is also confirmed by the calculations made by König et al. (2020).

One adaptation to the lower-energy season is the increased mass of the rumen filling, coupled with the seasonally reduced size of the rumen. In summer, adult animals have an average rumen content of 3.39 kg and rumen volume of 6.4 litres, whereas, in winter, they have a rumen content of 4.03 kg and rumen volume of 5.5 litres. The energy requirement is met by compensating for a decrease in the quality or availability of the energy with an increase in the mass of the rumen filling. We were able to demonstrate the same adaptation for the roe deer.

(4) In the habitats we studied, we were thus able to show that the animals do not suffer from a shortfall in the energy supply at any point in the year and that instead, they adapt flexibly by increasing their food intake.

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Exploring the use of a carcass detection dog to assess mowing mortality in Hungary

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The intensification of agriculture has resulted in changes to mowing techniques. Slow manual cutting gave wild animals time to move to safer habitat patches and left hiding places for them. With the arrival of much faster mowing machinery this is no longer the case. To date, there are few ways of measuring direct mortality of new mowing capabilities on wildlife. In our study we aimed to answer whether a search dog, previously trained to find carcasses, could be used to assess mowing mortality of various species in different vegetation types in Hungary. Working with a handler, a carcass-trained dog fitted with a GPS surveyed several habitats post-mowing. All the animal remains detected were identified and recorded. One hundred forty-nine killed individuals were detected on 12 land parcels studied (158.2 carcasses/100 ha). The most affected vertebrate group was the reptiles (57%), all with protected status in Hungary, followed by mammals (30%) and birds (6%). Reptiles were predominantly represented by lizards, while rodents were the most common mammals found (91% and 70%, respectively). The dog also found dead brown hares, pheasants and roe deer (11% of all carcasses), which has implications for local wildlife managers. There was no statistical difference in the density of dead individuals between grassy meadows and leguminous vegetation or in those found in the morning or afternoon. The mortality rate was not associated with the area of the mowed field. Our findings suggest that this is a viable use of carcass detection dogs. We recommend additional work of this kind to reveal the fatal impacts of new, faster-mowing practices on wildlife living in agricultural landscapes to help mitigate conservation and game management conflicts.

Using media content analysis to assess the European turtle dove management conflict in Spain

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This study analyzed how the online media covered the European turtle dove (*Streptopelia turtur*) decline and the conflict associated with its management in Spain. In particular, we aimed to assess: 1) whether this coverage varied between 2015 and 2019; 2) whether the positions of

hunters or environmentalists predominated in the media over those of the other party; 3) the frequency of criticisms in the media against the collectives involved in turtle dove management, and 4) how hunters and environmentalists portrayed in the media the causes of and solutions to the turtle dove decline. To do this, we searched in the Internet documents containing several combinations of words, including “conflict-hunting-European turtle dove”, “problem-European turtle dove”, or “hunting-European turtle dove”. Data analysis consisted of reading and re-reading the documents to identify the main themes covered. A total of 146 papers were found, with the number of documents increasing over the study period. Our results show that the positions of environmentalists predominated in the documents, particularly in the general media and environmental websites. The documents showed very rarely the views of both collectives simultaneously, potentially contributing to polarization. Criticisms against hunters predominated in the documents and were even relatively frequent in hunting websites, suggesting some degree of hunters’ self-criticism. The main causes of turtle dove decline reported in the media were habitat loss, agriculture intensification, and hunting. The latter is more frequently shown in the general media, particularly in environmental websites, than hunting websites. In addition, the main solutions to revert the turtle dove decline identified by our analysis were establishing a hunting moratorium, conducting habitat management and reducing hunting pressure. The hunting moratoria predominated in the general media and environmental websites. In contrast, other actions like reducing hunting pressure, promoting habitat management or investing in the research were preferred in hunting documents. In conclusion, our study points at the relevance of assessing media coverage of wildlife-related issues to understand human-wildlife interactions.

Acceleration of the century: determinants, assessment tools and management challenges of the red deer population in Latvia

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The last century has experienced enormous changes – from the agrarian reform in the early 20th century to the current technological explosion. Latvia is a typical example of how populations of wild animals are managed according to existing knowledge. In contrast, the management of natural resources for various human needs is influenced by diverse political and economic factors, which can have conflicting or unforeseen effects. In this study, we focus on red deer *Cervus elaphus* (RD) - a purposefully reestablished species in Latvia after complete extinction for trophy hunting and which recently is causing severe conflicts with forest owners and farmers. The study aims to highlight factors and suggest solutions that need to be considered for sustainable management and survival of the local RD population in the future.

Over the last 21-year period, the estimated number of RD has grown threefold – from 21,000 in 2000 to 66,000 in 2020. The total harvest amount has increased even more – from nearly 5,000 animals at the beginning to more than 25,000 animals in the last hunting season. Two periods were compared: 2000-2009 (TI) and 2010-2020 (TII). Official statistics about harvested RD sex and age structure (State Forest Service) were used. We compared the proportion of

hunted hinds per stag (female index FI), harvest quota fulfilment, the intensity of forestry (defined as changes of tree stand area up to 10 years age) (State Forest Register), and the area of young tree stands protected from deer browsing (JSC “Latvia’s State Forests”). At the end of TII, the intensity of damages to forestry was measured by assessing fresh (winter/early spring) browsing signs in 600 young stands (our data). Winter pellet piles were also evaluated in the same stands and categorized into species, sex and age groups, and an RD female pellet index (FPI) was determined.

The hunted FI was significantly lower in TI than in TII (0.96 ± 0.02 and 1.39 ± 0.13 , respectively). The harvest quota fulfilment for RD stags and fawns was considerably higher in TII, but there were no differences in hind quota fulfilment between the two periods. There is a strong negative correlation between RD FI and RD FPI ($r = -0.76$). There is a strong positive correlation between RD population estimates, area of young forest stands, and protected stands ($r = 0.91$ and $r = 0.98$). The main results are presented in **Figure 1**.

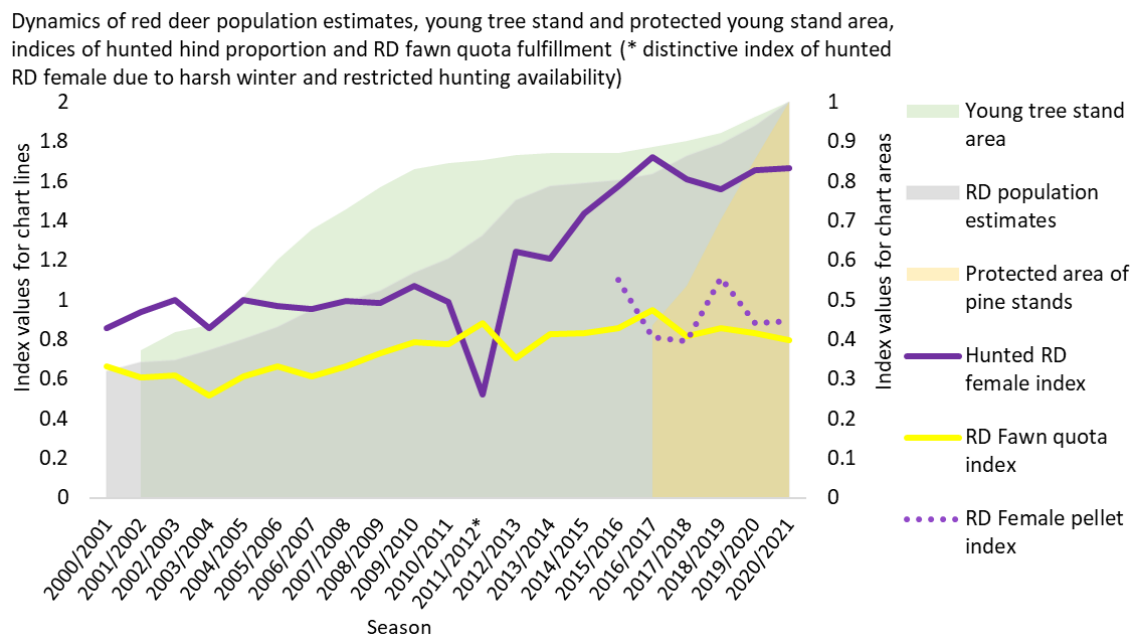


Figure 1. Main results of the study

The study suggests a few determinants of the rapid RD population increase and its unwanted consequences: environmental gradients related to a general change of forest use, human-caused shifts in RD population structure and inadequate game management policy. The game policy should become more flexible by integrating new census technologies such as trail cameras, acoustic recorders, drones etc., adjusting harvest quota and pressure adaptively to rapid changes in population growth, age and sex structure.

The influence of climatic changes on the reproduction of roe deer in Bavaria

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The European roe deer (*Capreolus capreolus*) is one of Germany's most relevant game species and has been the subject of numerous scientific studies. Nevertheless, knowledge about this native game species is still incomplete in some areas. The focus of this study is embryonic diapause, which is a unique reproductive strategy of this species. It is still unclear by which factors this process is significantly controlled. As a possible factor, the influence of climatic changes on embryonic diapause will be considered in this study.

Uterine samples from deer from November to January were examined for the study. The samples were collected from 2017 to 2020 during the regular hunting season in different areas of Bavaria. The weight of the females was recorded, and the age was determined from the teeth. It was investigated whether the animals were pregnant and at what point better-developed embryos were detectable in the uterus. The embryos were measured, and their developmental status was assessed. In addition, corpora lutea were recorded on the ovaries.

The embryonic diapause phase is characterized by delayed implantation and severe slowing of embryonic growth during early embryogenesis. The literature describes that this phase ends at the end of December. From this point on, the embryo develops at a rate comparable to other mammals. In this study, higher developed embryos could be detected already at the end of November. By mid-December, embryos up to 9 mm in size were recorded. The size of some embryos from January also suggests that implantation occurred before the end of December. The study results showed possible evidence that European roe deer respond to climatic changes by ending embryonic diapause earlier than previously described in the literature. However, earlier implantation could indicate a tendency that the birth time could occur at an earlier date. Based on these results, a further study was conducted with a comprehensive methodology, allowing more precise conclusions to be drawn about the end of embryonic diapause. This investigation is still in the evaluation stage.

Impact of the Covid-19 pandemic and African swine fever on wildlife disruption: Different patterns of human activities in nature

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Human recreational outdoor activities harm the wilderness. The excessive presence of humans in animals' natural environment can negatively affect their energy expenditure, behaviour, or

physical fitness, leading to changes in activity, reproduction, and survival itself. Tourism is therefore considered one of the main threats to natural ecosystems. The study aimed to evaluate the intensity of human outdoor activities during the outbreak of African swine fever (ASF, complete entrance ban) in 2018 and the COVID-19 pandemic (C-19) in 2020 and to compare it with the standard forest standard rate of tourist's visits of forest represented by the year 2019. The monitoring was performed in a forest northeast of Zlín, Czech Republic. The data were obtained from May to June for three consecutive years. The presence of humans and common animal species was monitored by 14 randomly placed camera traps (1 camera trap per 100 ha of forest).

Similarly, to other such studies, all the camera traps were placed off the forest road. The camera traps recorded 241 people in the study area (30 people in 2018, 84 in 2019 and 127 in 2020). In the study area, the effect of the C-19 pandemic was seen as a dramatic change in human use of nature. We recorded a 51% increase in visitation using camera traps during the C-19 in the 2020 period compared to the previous year in the study. The frequency of forest visitors was compared with the time before the C-19 and the year 2018 when a strict ban on entering the monitored area was implemented due to the outbreak of the ASF. The number of visitors during the entry ban in 2018 decreased by 64% compared to the standard year. The effectiveness of the entry ban in the ASF-infected area is therefore quite debatable. We also evaluated the frequency of animal presence during "human-affected" periods (within 24 hours of human detection) and unaffected periods (more than 24 hours after the detection). The average frequency of animal visits within 24 hours of human presence was 1.41 visits per day (95% CI 0.94–1.88); in the unaffected periods, it was 3.76 visits per day (95% CI 2, 79–4.73), which means an increase of 167%. The effects of risk predict that the animals will avoid human disturbance and react as in a conflict situation with a predator, which our study confirmed. The results suggest that entry management measures are critical, especially in areas with endangered species, which are much more sensitive to human disturbance.

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Interest for the biodiversity of agricultural water reservoirs. Results of investigations carried out within the GIASC¹ of Villeréalais (South-West France).

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In Haut-Agenais, in the South-West of France, the GIASC (Agricultural/silviculture and hunting Interest Group) of Villeréalais brings together the communal hunting associations of a territory of 170 km² agricultural hillsides. The landscape is dominated by mixed cereal crops, mainly straw cereals and arboriculture, principally plum (the Agen prune) and hazelnut (Koki

hazelnut). Cattle farming is still well represented, and numerous open-air poultry and duck (foie-gras) farms. The average afforestation rate is close to 15%. The mesh of hedges is still dense. These landscapes offer an exciting diversity of habitats for wild fauna, particularly small wildlife of fields.

Adapted hunting management is implemented for small game and waterfowl, and habitat conservation actions are carried out in a partnership approach with farmers. These actions have a beneficial effect on the whole biodiversity of these ecosystems. The European Wildlife Estates label has been granted to the GIASC of Villeréalais in this regard. The FDC (Departmental hunting federation of Lot-et-Garonne) relies on these actions to raise awareness and training in hunting management, improving the quality of wildlife habitats and conserving biodiversity.

A unique feature of this territory, many artificial ponds were dug at the foot of the hill during the 1980s and 1990s to collect and store runoff water in winter, to use them for irrigation of crops during summer, or sometimes to support low-flow rivers which are pumped for the same agricultural needs. The dynamic of creating these ponds has weakened considerably since the mid-2000s due to a hardening of public policies regarding the use of water resources and terms of the conservation of natural wetlands. Regarding this last point, it should be noted that these artificial ponds are reported to increase the turbidity and temperature of rivers downstream but also as responsible for their drying up in summer.

To date, the GIASC territory has more than 200 of these artificial ecosystems, close to 1 to 2 per km² on average. Before their creation, in the absence of marshes and wet meadows, only the streams and rivers network and a few ponds pre-existed, the last vestiges of a time when they were necessary for breeding. In this context of typical agricultural landscapes of southwestern France, particularly anthropized and little provided with natural wetlands, these ponds seemed appropriate to characterize from the point of view of the interest they can represent for biodiversity. Reinforcing the relevance of this work, the latest orientations announced by the Government plead in favour of resuming policies to create these water storage ponds, more particularly in the south of France, concerning crops irrigation needs to be increased by climate change.

As part of a master's internship in "Biodiversity Management" at the University Paul Sabatier of Toulouse, an exploratory study was carried out as part of a sampling of this type of artificial pond. The work initially consisted of looking at the biodiversity present in these ponds. The Odonata and macro-invertebrates, biological taxa indicators of water quality and biological richness were inventoried while observing in parallel the environmental parameters likely to influence them, within the framework of a comparison with the historical ponds like a natural habitat.

Secondly, in an approach based on both inventories and the interest of these ponds as habitats or as their populations are part of the trophic chains or as an essential link in the functioning of a complex ecosystem, the investigations focused on mammals, avifauna and herpetofauna, certain are species of heritage interest or targeted by European nature conservation policies. The connectivity of these wetlands between them and the possibilities of species to spread was also questioned.

The challenges and main problems of urban wildlife management in the Belgrade area (Serbia)

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The area of Belgrade is the most complex part of Serbia in terms of economic activity, urban development and traffic. It is located at an altitude of 71-628 m. It is divided into 17 municipalities that cover about 3,220 km², with a population of over 1.5 million inhabitants living in the area. Hunting associations with about 6,000 members (hunters) manage ten hunting grounds covering over 90% of the total hunting areas in this territory. Various game species are present in this area, such as roe deer, pheasant, brown hare, wild boar, grey partridge, jackal, fox, and many others. This paper aims to identify the main challenges and problems of urban wildlife management in the Belgrade area, emphasising the estimated number and total use of significant game species during the period 2001-2019. Data from various sources were used, including the Statistical Survey on Hunting (municipal level, www.stat.gov.rs), Hunting Industry Development Program in Serbia 2001-2010 (2001), official records of hunting ground users, and the database of the Forest Directorate (hunting ground level). The field research was carried out in the hunting ground “Topčiderska Reka”, which is located near the centre of Belgrade. We used six camera traps (Ltl Acorn) set up in feeding sites for wildlife and their migration paths from February to June 2021. The results show that the biggest challenge is habitat loss for all wildlife species, while at the same time, natural conditions are deteriorating daily in the rest of the habitat, primarily due to the development of industry, construction of traffic infrastructure, expansion of settlements, intensification of agricultural production, as well as deforestation, or conversion of forests into agricultural and construction land. It is concluded that the main problems of urban wildlife management in the Belgrade area are excessive use of wildlife populations, burning of vegetation residues on arable land and its edges, wildlife-vehicle collisions, damage from wildlife in agriculture, the increasing number of dogs and cats moving without owner control in hunting grounds, poisoning of wildlife with herbicides, frequent droughts, as well as the pollution of soil, watercourses, and air.

Wildlife Value Orientations and hunting in Southern Spain

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Wildlife value orientation (WVO) surveys constitute a unique approach to explain patterns of human intention towards behaviour related to wildlife. Individuals with a domination value orientation believe that wildlife should be managed primarily for human benefit, finding more

likely justification for managing wildlife in utilitarian terms. Individuals with a mutualism orientation view wildlife in human terms and as part of an extended family, thus deserving of rights and cares. They are less likely to support actions resulting in the death of harm to wildlife. Therefore, WVOs may influence how people view hunting, as several studies in the USA and northern Europe have demonstrated.

However, WVOs of the general public, particularly how such values correlate with attitudes toward hunting, have not been assessed yet in southern Europe, where activities involving animals like hunting have been traditionally deeply rooted in society. Our main goals in this study were 1) to assess WVOs in Andalusia (southern Spain), 2) to determine to what extent the WVO scale was reliable in this region, and 3) to explore the correlation between WVOs and how people view hunting.

We interviewed online or by telephone 750 people (>18 yrs) using a stratified consumer's panel (which controlled for rural-urban residence, age and gender). The questionnaire consisted of 40 questions, including those of the WVO scale, respondents' sociodemographic characteristics, and if they practised hunting. In addition, some questions aimed to assess respondents' degree of agreement with regards to hunting or lethal control of wild animals when impact other species of recreational hunting interest (i.e. predator control) or cause crop damage or may transmit diseases to other animal species.

Reliability analysis confirmed that the WVO scale is also potentially applicable in Southern Europe. Andalusians represent the highest proportion of mutualists. The lowest utilitarian reported so far in the literature is almost the opposite of our prediction, as hunting in this region is an important socio-economic activity. Surprisingly, the proportion of mutualist-oriented was dominant even among Andalusian hunters, although they were more utilitarian-oriented than those non-hunters.

Considering WVOs on a utilitarian-mutualism continuum scale, the utilitarianism orientation was positively associated with the support to hunting and all the options considered of lethal control of wild animals. In contrast, the mutualism orientation was negatively related to the support to hunting and all lethal managements of wildlife, except for the one devoted to controlling wild animals transmitting diseases.

Since mutualist orientation seems to be growing where measured, our result suggests that the low hunting support will probably decline in the future, risking this activity and its associated managements seriously, even in Andalusia, where >70% of its surface is currently covered by hunting states.

Life MICA project: Management of invasive coypu and muskrat in Europe

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Objective: Due to globalization, species increasingly establish outside of their original range. Those species are called invasive if they threaten biodiversity or cause economic damage in their new habitats. The EU regulation No. 1143/2014 prescribes measures for the protection of biodiversity, for the prevention of introduction and the management of alien invasive species.

Among others, coypu (*Myocastor coypus*) and muskrat (*Ondatra zibethicus*) are listed as invasive species of Union concern. Both species are semi-aquatic rodents, their genuine habitat lies in South and North America, respectively, and they settled in Europe during the 20th century. They may feed on riparian vegetation or crops, dig tunnels in waterbanks or dams and dykes and thereby threaten ecosystems and habitats of protected species, waterway infrastructures as well as agricultural areas. Coypu and muskrat are established all over Germany and are also spreading continuously in the Netherlands and Belgium.

Methods: The Life MICA project (Management of Invasive Coypu and MuskrAt in Europe) is a cooperation between German, Dutch and Belgian institutions¹ with the aim of establishing an efficient management of coypu and muskrat by developing innovative cross-border methods for their population control. Between 2019 and 2023, the following methods are tested in 11 project areas: for early detection of the presence of coypu and muskrat, water samples are screened for the presence of DNA material of both species (environmental DNA). Furthermore, camera traps are set up on waterways and images are screened for coypu and muskrat presence with the help of an algorithm. By DNA analysis of captured animals, relationships between populations are determined in order to detect migration routes of the species. Additionally, smart life traps, which selectively close for coypu and muskrat will be tested aiming to prevent bycatches of protected species as beaver and otter. The impacts of coypu and muskrat on biodiversity are investigated by mapping of aquatic vegetation, bird populations and dragonflies in the project areas and comparison with data on the occurrence of coypu and muskrat. Finally, the Life MICA project networks with other initiatives in the field of management of invasive alien species and creates public awareness on this topic through public outreach work.

Results: The duration of this project is scheduled until 01.09.2023. Up to now, due to the Covid-19-pandemic, only minor delays have been addressed.

Conclusion: This project helps to provide the basis for a successful long-term population management for coypu and muskrat in Europe.

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Coexisting with different human-wildlife coexistence perspective

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Over the last decade, there has been a remarkable increase in scientific literature addressing human-wildlife interactions and associated concepts, such as coexistence, tolerance, and

acceptance. Despite increased attention, these terms are rarely defined or consistently applied across publications. Indeed, the meaning of these concepts, especially coexistence, is frequently assumed and left for the reader to interpret. To better understand these terms, we conducted two World Café sessions at international conferences in Namibia, Africa and Ontario, Canada. Here, we present the array of perspectives revealed in both workshops and build upon these results to describe the meaning of coexistence as currently applied by conservation scientists and practitioners. Although we focus on coexistence, it is imperative to understand coexistence in relation to tolerance and acceptance. In many cases, these latter terms are used to express, measure, or define coexistence. Drawing on these findings, we discuss whether a standard definition of these terms is possible and how the conservation field might move toward clarifying and operationalizing the concept of human-wildlife coexistence.

Genetic differentiation between Asian subspecies of red deer (*Cervus elaphus*) of Russia: cytochrome b and microsatellite analysis.

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Red deer is an ungulate species with an extensive Holarctic range. There are four subspecies of red deer which inhabit the territory of Russia, two of them (Siberian wapiti (*C. e. sibiricus*) and Far East wapiti (*C. e. xanthopygus*)) inhabit the Asian part of the country, the rest (*C.e. hippelaphus* and *C.e. maral*) inhabit the European part.

Siberian wapiti populates southern Siberia (up to Lake Baikal) and is actively bred in hunting and farming facilities. Far East wapiti populates Trans-Baikal and the Far East. These subspecies differ at the genetic, morphological, and acoustic levels. At the same time, the boundaries of their distribution remain unclear; there are populations with intermediate features across Baikal and in Yakutia. The molecular analysis of rapidly mutating microsatellites (MS) makes it possible to identify red deer subspecies accurately. We aimed to describe the MS diversity of studied populations and reveal private (i.e. common only for one population/subspecies) alleles. We also conducted mtDNA cytochrome b (*cyt b*) analysis to reveal the phylogenetic position of studied animals and to confirm their subspecies.

We analyzed 114 samples of Siberian (60) and Far East (42) wapiti from different locations (both free-living populations and two Siberian wapiti farms) and 12 samples from individuals of unclear taxonomic status from Yakutia. The MS analysis was performed using eight loci. For phylogenetic analysis, 73 *cyt b* (1030 bp) sequences from the same animals were used.

As a result, 37 *cyt b* haplotypes were revealed, and no common haplotypes were found for Siberian and Far East wapiti. The Maximum Likelihood tree showed two main clusters (Far East and Siberian wapiti); however, some Siberian wapiti clustered together with Far East wapiti. Haplotypes from Yakutia entered the “Siberian” cluster. Net genetic distances were less between Yakutia and Siberian wapiti (0.0016; SD = 0.0005) than between Yakutia and Far East

wapiti (0.0097; SD = 0.0028) and between Siberian and Far East wapiti (0.0080; SD = 0.0022). The results of MS analysis with STRUCTURE algorithm showed the number of subpopulations (K) = 2. We found 24 private alleles (15 for Siberian and 9 for Far East wapiti and no private alleles for Yakutia). Fst genetic distances were less between Siberian and Far East wapiti (0.011) than between Siberian wapiti and Yakutia (0.045) and between Far East wapiti and Yakutia (0.034). This could represent the history of natural male migrations and the possible mixing of Siberian and Far East wapiti. In general, microsatellite analysis can be used as a marker at the subspecies level to identify individuals of mixed origin and differentiate individuals and populations of red deer in Russia.

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Wildlife survey in Lower Saxony 1991-2021 – an adequate monitoring program of population densities and trends as a basis for wildlife management

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Purpose/Objective: It is commonly accepted that decisions regarding wildlife management must be based on information about the occurrences, population status and dynamics of the respective wildlife species. Consequently, the Hunting Association of Lower Saxony (LJN) established the wildlife survey of Lower Saxony** (WTE = WildTierErfassung) in 1991 in cooperation with the Institute for Terrestrial and Aquatic Wildlife Research. The survey aims to evaluate the sustainability of hunting, assessing hunting modalities and providing a database for decisions in the context of the hunting law and guidelines.

Material/Methods: The federal-state Lower Saxony is divided into approximately 9,000 hunting districts. The average hunting district area is 500 ha (minimum: 75 ha, maximum: 7,300 ha). Holders of hunting districts and foresters are annually requested to estimate the occurrence or abundance of several wildlife species in their hunting district. Furthermore, they are asked for data on hunting bags, reproduction, diseases, and their opinions on subject-related events and discussions, e.g. the recovery of wolf and lynx in Lower Saxony.

The quality of the survey data was assessed by random evaluation with studies based on standardized monitoring methods

Results: Since 1991, approximately 8000 holders and foresters of hunting districts have participated (participation rates between 80% and 90%) every year, which translates to an area of 37,000 km² covered. In total, data on 53 species were collected annually or even more frequent as part of this survey. Hare, pheasant and rabbit showed a significant increase in population densities from 1991 to the mid-2000s and a sharp decrease again since 2006. The partridge population, for example, has decreased between 64% and 97% in the various regions of Lower Saxony since 1991 but still occurs in 43% of the hunting districts. Due to the negative

population trend, 99.6% of the district holders followed the LJN's call to stop partridge hunting voluntarily. However, due to the voluntary hunting stop (partridge) or intensified hunting guidelines (wild boar ASP prevention), for example, for the various game species, it is no longer possible to derive population densities from the hunting bags today. This highlights the importance of the annual survey and demonstrates its value for wildlife management.

Conclusion: Hunters and district holders represent a highly motivated and competent survey target group, reflecting high participation numbers. Based on the recorded data, we can conclude the occurrence and long-term development of populations locally. The dataset describes the biodiversity in Lower Saxony, records changes and is the basis for mandatory monitoring programs. In combination with biotic and abiotic environmental data (landscape change, weather), we can further investigate the rationale of population developments and adopt our wildlife management strategy accordingly. Additionally, the inquired opinions of hunters and district holders on the influence of large predators such as wolves and lynx on their prey species (*e.g.*, roe deer and red deer) can be used in conflict management. In summary, the WTE is an effective monitoring program, which proved crucial for data-driven and reasonable wildlife management and only relies on an interested and proficient group of people to provide data under scientific guidance based on citizen science under scientific cooperation

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Is unselective hunting selective? Using ringing recoveries of birds as a model study

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The impact of selective harvest has long been studied as part of trophy hunting, especially in some mammal species and fisheries. Such a selection process can have various effects on the harvested population: decrease in average antlers, horns or tusks height, modification of population structure or dynamics, ... In this context, the hunter or fisherman intentionally selects the selection. Still, it can also be unintentional when some animals have characteristics that make them more or less accessible or vulnerable to harvest. Again, unintentional selection has been mostly studied in fish, but some studies show that the behaviour of individuals can also influence their vulnerability to hunting in mammals, snakes and birds. While most of these studies address vulnerability to harvest as a function of behaviour, there is a likely correlation between behavioural types and morphology, as predicted by scaling and demographic invariant theories.

Here we considered bird hunting in Europe to study unintentional selectivity in the harvest. Such a model is particularly relevant in view of the high annual harvest rate: at least 52 million birds are harvested each year in Europe. The analyses were based on ringing data from several

hundreds of thousands of individuals ringed between 1929 and 2020 in 7 bird species, including several migratory species: Eurasian Teal (*Anas crecca*), Mallard (*Anas platyrhynchos*), Common Pochard (*Aythya ferina*), Tufted Duck (*Aythya fuligula*), Common Blackbird (*Turdus merula*), Common Snipe (*Gallinago gallinago*) and Eurasian Coot (*Fulica atra*). Using analyses of covariance, we compared morphological traits (mass, wing and tarsus size) and body condition at the time of banding between birds that were subsequently recovered from hunting during the same season as their banding and birds not recovered. Contrary to a frequent assumption that hunting preferentially removes the weakest individuals, our results do not show any real selectivity of hunting on the traits we tested. In the few cases where a statistically significant occurred, such a minuscule order of magnitude was barely effective on biological grounds. If our results do not show selectivity on morphological traits or body condition, we suggest pursuing the same type of analysis on behavioural traits since several studies, including one on birds, show a non-intentional selectivity of hunting on the behaviour of individuals.

Is hidden individual heterogeneity actually a common feature in game bird species?

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Harvest can have effects on both population dynamics and evolutionary trajectories. In this context, individual heterogeneity is a significant concept because, on the one hand, this difference between individuals allows selection and thus evolution. On the other hand, individual variation in demographic parameters, like survival or fecundity, directly influences population dynamics. Many studies focus on visible heterogeneity such as sex or age groups. Few studies have instead considered hidden heterogeneity, that is, persistent individual variation beyond visible groups. In our study, we looked for the presence of hidden individual heterogeneity in survival rates of seven harvested species: Eurasian Teal (*Anas crecca*), Mallard (*Anas platyrhynchos*), Common Pochard (*Aythya ferina*), Common Blackbird (*Turdus merula*), Common Snipe (*Gallinago gallinago*), Eurasian Jay (*Garrulus glandarius*) and Common Quail (*Coturnix coturnix*). This work was based on Capture-Mark-Recapture (CMR) data spanning from 1953 to 2020 with data sets ranging from 10 to 65 seasons and several hundred individuals ringed for each species. Our model allowed us to detect hidden individual heterogeneity in all the species we studied. This study also shows how the species we studied fit along a gradient of individual variance for survival rate and life-history traits. We were also interested in which variables could explain such individual heterogeneity. If hidden individual heterogeneity had already been demonstrated episodically, mainly in studies focused on a single species, our work shows that this phenomenon is truly very common in most species. The survey of individual heterogeneity is all the more critical in game species. It allows a better understanding of

population responses to harvesting, individual heterogeneity for survival rate being, for example, directly related to the capacity of a species to compensate for harvest.

On the consequences of the Birds Directive: testing the effect of earlier hunting closure on Teal (*Anas crecca*) numbers at a major stopover site

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The European Birds Directive prevents the hunting of migratory birds during their return migration journey to their breeding grounds. This is based on the knowledge that the value of the live individuals in the population is then at its annual maximum: their harvest would have the most detrimental consequences for population dynamics. Allowing them to prepare for the breeding season to come should translate into more significant numbers of young produced. Hence, the European Member States regularly update the Key Concepts of the Directive with fresh information on bird migration dates to adjust hunting season dates accordingly. Because of the Birds Directive, the closure of the waterfowl hunting season has been considerably advanced over the last decades. Yet, the way birds respond to such changes in the field has seldom been documented. Relying on long-term (55 years) waterfowl censuses in Camargue, southern France, one of the strongholds for this species, we evaluated how the cessation of March hunting (in 1980) and of February hunting (in 2002) correlated with the number of birds using the area during these months. Teal numbers reacted promptly to the cessation of hunting in February. The abundance of birds in the Camargue during that month showed an abrupt stepwise 1.5 times increase after 2002, and no significant trend over time before or after that date. In March, conversely, Teal numbers gradually increased over the 55 years of study: the cessation of hunting may have contributed to this increase but was not the only factor at play. Our results show that the end of hunting does translate into greater use of this wintering ground and stopover by migrating Teal during spring, hence likely allowing them to prepare for the rest of their journey and the next coming breeding season in the best conditions.

Stress assessment during hunting activities – use of bio-logging data

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Hunting is part of human culture for three million years. First considered as only food acquisition, it is now part of every wildlife management strategy. Predominantly driven hunts, where a larger group of hunters and beaters with or without hunting dogs work together to reach predefined goals, are good tools to manage population levels. Concentrated on a small number of days during the winter months, driven hunts aim to decrease hunting pressure and hunting-induced stress. However, other approaches state that driven hunts increase stress. Measurement of stress in free-ranging animals remains challenging and often involves shooting/capturing. The continuous development of tracking devices promises alternative methods, with using bio-logging data to determine physical activity and energy expenditure being one of them.

We aim to determine the use of multisensory collars attached to free-ranging wildlife species such as wild boar and red deer to measure body acceleration and movement behaviour in response to hunting events in two different areas with opposing hunting intensity in the Czech Republic. So far, bio-logging data is available from 6 red deer and 17 wild boar, with more data constantly incoming. Overall dynamic body acceleration (ODBA) and the vector of the dynamic body acceleration (VeDBA) are considered good proxies for energy expenditure. They can be calculated using three-axial acceleration data obtained from bio-loggers attached to the collars. Movement behaviour is defined using daily movement distance, home range and step-selection functions (SSFs). In general, we found that wild boar try to avoid hunting activities but return to their initial home range in a span of a few days, which was also observed in other studies. The movement behaviour observed in red deer showed similar patterns. In response to the disturbance, energy expenditure is increasing, and step length is decreasing. We found high variation in movement behaviour and energy expenditure among individuals. This was also found in studies engaging stress using hormonal analyses, indicating the importance of individual identification during stress-related research. Hunting intensity (quantified using the number of hunters, dogs, and size of hunting area) and hunting type (driven hunt vs single hunt) further altered movement behaviour in wild boar and red deer. Understanding the different avoidance behaviours, stress, and individual variability could help optimizing hunting strategies to maximize the effect with serious consideration of animal welfare.

Wintering population increase in the Arctic-breeding Greater White-fronted Goose (*Anser albifrons*) in the Hortobágy (Hungary)

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Climate change affects migratory birds in time (phenology), space (use of stopover sites, staging and wintering areas) and numbers (numerical difference). We assessed these long-term changes by using data from the monitoring of the phenology and size of the Pannonic flyway population of Arctic-breeding Greater White-fronted Geese (*Anser albifrons*) in regular weekly counts Fishponds of the Hortobágy National Park (east Hungary) between 1989 and 2019.

We found that the flyway population size increased considerably from 2000 to 30,000 in 30 years, more so in the spring than in the autumn migration.

Since 2007, an increasing number of Greater White-fronted Geese have overwintered the study area, which had not been used for wintering before. A positive relationship between December peak counts and mean temperature suggested that milder winters played a role in this increase. However, there was no long-term trend in the mean temperature of any month over the study period, indicating the little direct, local impact of climate change.

Because land use and management also changed little in the study period, we conclude that the increase of Greater White-fronted Geese results from the general rise in flyway population size, which was recently reported in other studies. The establishment of the new wintering area is probably based on this increase and made possible by milder winters since 2007.

Our long-term study thus provides evidence of climate change-related modifications in migration phenology, spatial re-arrangement of the wintering grounds, and large-scale increase in population size detectable at the local scale in an important staging area.

Dusky leaf monkeys popular on YouTube: rising illegal exotic pet trade on social media in Southeast Asia

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YouTube has become an increasingly popular social media platform for the illegal exotic pet trade of dusky leaf monkeys (*Trachypithecus obscurus*) in Southeast Asia. We identified the number of pet dusky leaf monkey videos, their popularity, and engagement on YouTube. One

of the authors identified videos with English-language and local language search terms for four Southeast Asia countries (Malaysia, Indonesia, Thailand, and Myanmar) from September till October 2019 to establish a prior understanding of the potential importance of the illegal exotic pet trade demands through YouTube. The number of videos portraying pet dusky leaf monkeys increased from 2016 to 2019, and in parallel, their popularity and engagement had also increased. The highest increases in both the number of videos produced and their popularity occurred in Malaysia and Myanmar. The results reflect the current "trending" videos that existed to influence posting viral pet dusky leaf monkey videos at an international rate. Potentially compelling videos tended to be established at a domestic rate by five individual dusky leaf monkey owners. Based on comments such as "I want a baby monkey" and "I like to get one" in the English-language videos, it showed the potentials for driving demand amongst their viewers. These increases in popularity and social media activities highlighted the portrayal of the dusky leaf monkey as a suitable pet. Based on the results, we advise strengthening the wildlife trade legislation and regulating social media in keeping pace with the rapidly shifting nature of the Internet worldwide.

Monitoring of Red Deer *Cervus elaphus* and Fallow Deer *Dama dama* using thermal imagery from UAV

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Purpose/Objective: Knowledge of density and population size is necessary for the effective management of deer. The most common method in Denmark to estimate the population size is the spring census, i.e. after the hunting season and before calving. However, because reed deer and fallow deer have large home ranges, it is difficult to register all individuals. Especially deer hiding in forests are hard to find, and thus it's assumed that only 60-80% of the animals are registered. To get better population estimates, the main aim of this study was to develop a method to monitor the number, sex and age of red deer and fallow deer in forest areas using a drone with a thermal camera.

Material/methods: We collected the UAV imagery in winter using a DJI Matrice 210 quadcopter with a DJI Zenmuse XT2 TIR camera 19 mm lens, including a 4k visual lens (dual camera). To identify the species in the thermal pictures, a calibration was made based on drone pictures from a fenced deer reserve, where deer species, number, sex and age were known. The length, width, circumference and area of the animals were measured on the imagery and pixels were converted to meters, testing for measurement differences between species, sex and age classes using t-tests. Thermal images were then collected from a Danish forest with large Red and Fallow Deer populations, and species, gender and ages were identified or estimated based on the calibration data.

Results: Animal length significantly differed between species allowing differentiation between Fallow and Red Deer ($p < 0.001$), which showed the least overlap between species. However, there was no significant difference between adult male Fallow Deer and juvenile Red Deer (Fig 1). There was a significant difference between sexes in Fallow but not Red Deer. In most of the thermal pictures, it was possible to detect and differentiate between species when using the method in forest areas, covering 100 ha per hour from a height of 100 m.

Conclusion: Drones with thermal cameras can be used to effectively locate, identify and count Red and Fallow Deer in forest areas. Although a single drone can only cover a limited area, the simultaneous use of several drones to secure coverage of large areas or be used in combination with traditional monitoring methods to generate improved population estimates.

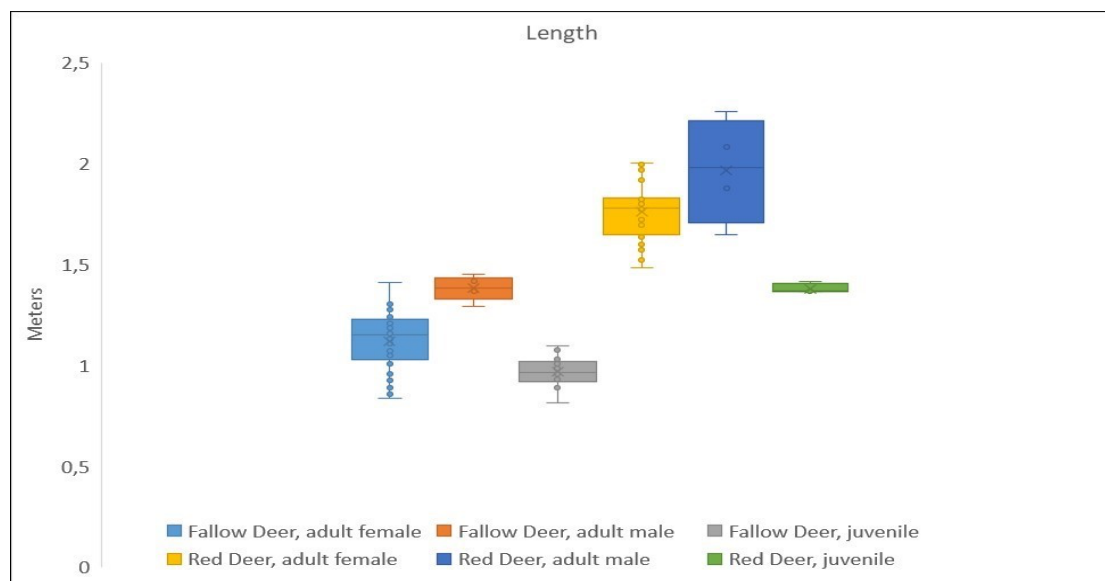


Figure 1. Length of Fallow Deer and Red Deer measured in thermal images.

Roe deer in Warsaw during Covid-19 pandemic

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Keywords: Covid-19, anthropopause, *Capreolus capreolus*, ungulate, urban forests, human disturbances, daily activity, moon phases

The surprising Covid-19 pandemic situation changed the activity of humans in urban areas, radically decreased people present during the lockdown, and then decreased the activity of people in human-modified habitat with increasing human activity in urban forests. Previous research showed that roe deer (*Capreolus capreolus*) stayed in the urban forest of Warsaw and

avoided more human-modified areas in the city, which might cause changes in roe deer activity during the pandemic situation. The study aimed to compare the activity of roe deer in urban forests in its reproductive period (March-August) before and during the Covid-19 pandemic. The research was based on camera trap survey (2019-2020, 859 observations, 5,317 trap-days in total). The peak of roe deer activity was recorded at dusk, and it changed with moon phases between spring and summer. Landscape connectivity and level of light pollution did not affect the activity pattern of roe deer. Our research showed that roe deer inhabiting urban areas avoided human presence by using well-covered habitats and being active in periods when the level of human disturbance was lower.

The colonization of the urban area by the red fox (*Vulpes vulpes*) and density changes of the rising urban population

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Purpose: Urban fox populations are widespread in cities worldwide, but the reasons for urban area colonization and the background of the process are poorly known. Therefore, our study aimed to describe the colonization of Warsaw by the red fox and document changes in its population density dating back to the 1970s.

Materials and Methods: For monitoring the progress in the city colonization, three different sources of data have been used: 1) the fox distribution assessment based on the presence-absence data over a grid of 1x1 km squares in years 2004-2012, 2) the process of settlement of the red fox in 29 randomly selected green areas (study periods 1976-1978, 2004-2012, and 2016-2019) in relation to habitat type (cemeteries, forests, parks, riparian forests), and 3) Spatio-temporal patterns of the red fox incidents (1998-2015) reported by Warsaw citizens. Additionally, in the three study periods, red fox density (in the whole city and various habitats) has been assessed by winter snow tracking on transect routes.

Results: Until 2015, red fox colonized the whole city area. The presence of this species was confirmed in all squares of the grid. 21% of the green places were colonized in 1976-1978, and they were primarily located in the city outskirts. This number rose to 62% in 2004-2012 and 93% in 2016-2019. Other green areas were inhabited gradually and closer to the city centre. Forests and riparian habitats were occupied more frequently than parks and cemeteries in 1976-1978, with no difference in the further years. The reports of city inhabitants were collected from the whole city. The probability of the fox incidents increased over the years, was the highest from June to October, on working days and around noon, and rose with the share of the discontinuous urban fabric in the buffers around incident locations. The average density of foxes has increased gradually since the 1970s in all habitat types. In the first period, fox tracks were registered only in forests and riparian areas in the Vistula valley. In the subsequent two periods, tracks were noted in each habitat type, but in the last period, track density was highest.

Conclusion: We documented the gradual colonization of Warsaw by the red fox and an increase in its density, dating back to the 1970s. Regardless of study time, one of the highest densities were recorded from forests and riparian habitats in the Vistula valley, which were also colonized primarily. This confirms the role of those habitats in the development of urban wildlife populations. The colonization of the city by the red fox started from a few abutments in the outskirts. It proceeded to the central areas, with further gradual population densities increase in a whole city. Our findings seem to confirm the general framework of city colonization by wildlife species.

Roe deer in Warsaw: habitat-related presence in winter and preliminary study on activity in the reproductive period

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Keywords: *Capreolus capreolus*; roe deer; ungulate; urban forests; human disturbances; daily activity; moon phases

Research conducted in Warsaw in the 1970s and 2000s showed that roe deer (*Capreolus capreolus*) stayed in forest habitats and avoided anthropogenic areas. Activity and exploration patterns of animals are shaped by indices of anthropogenic disturbances, elevated in big cities. The aims of the study were (1) to compare the presence of roe deer in natural and anthropogenic habitats of Warsaw during three periods of time: 1976-1978, 2005-2008 and 2017-2021; as based on snow tracking on transect routes (681.2 km in total), (2) to describe the presence and activity of roe deer in relation to human disturbances in selected urban forests in its reproductive period (March-August); as based on camera trap survey (2019, 859 observations, 5,317 trap-days in total). The number of tracks was higher in natural habitat in all three periods, with the highest value in 2017-2021 (9.85/km/24 hrs). The peak of roe deer activity was recorded at dusk, and it changed with moon phases between spring and summer. Landscape connectivity and level of light pollution did not affect the activity pattern of roe deer. Our research showed that roe deer inhabiting urban areas avoided human presence by using well-covered habitats and being active in periods when the level of human disturbance was lower.

Drone-based aerial monitoring of wild ungulates: a case study in Latvia

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Keywords: Drone, UAV, aerial imagery, elk, red deer

Precise assessment of wild ungulate population is essential for proper wildlife management and conservation. Standard approaches for wild ungulate population monitoring (e.g., winter pellet group or footprint counts) are time and resource consuming. Drone or an unmanned aerial vehicle is a relatively new technology that has become more widely available in recent years. Drones can cover relatively large areas in a short time and carry multiple sensors for data acquisition.

This study aimed to test the capability of drone-based aerial monitoring of wild ungulates and compare it with reference data from standard monitoring approaches. The chosen pilot territory was 1400 ha of woodland with wild pastures in Cesis county in Latvia. According to the winter pellet groups counted in 2019, the estimated wild ungulate population counted 6.9 elks *Alces alces* (3.0 bulls, 2.8 cows, 1.1 calves), 52.4 red deer *Cervus elaphus* (6.9 stags, 31 hinds, 14.5 calves), 7 roe deer *Capreolus capreolus*. Alternative estimation based on visual observations by hunting area ranger was 12 elks, 60 - 70 red deer, 40 - 60 roe deer.

DJI Matrice drone with dual-camera system *Zenmuse XT2* capable of acquiring visible light and thermal videos simultaneously was used for data acquisition; see image examples in **Figure 1**. It took 21 drone flights and 9 flight hours to cover the whole pilot territory. In total, 115 animals were detected – 17 elk, 76 red deer, 15 roe deer, 7 wild boar *Sus scrofa*. In the case of elk and red deer, drone-based population estimation showed a higher number of individuals in comparison to available reference data. The largest ungulates could be distinguishable using such a drone setup, thermal image data is crucial for detecting animals. Double counting issues could be spotted, and final population estimation corrected. However, detection of smaller ungulates (e.g., roe deer and wild boar) remains a challenge due to the limited spatial resolution of the thermal camera and their behaviour. The drone-based approach allows the localisation of detected animals from image data and mapping of animal distribution. Besides, a smaller (100 ha) and fenced deer garden area with a known number of red deer individuals were scanned twice to test red deer population estimation accuracy. It was possible to detect 87% of red deer individuals.

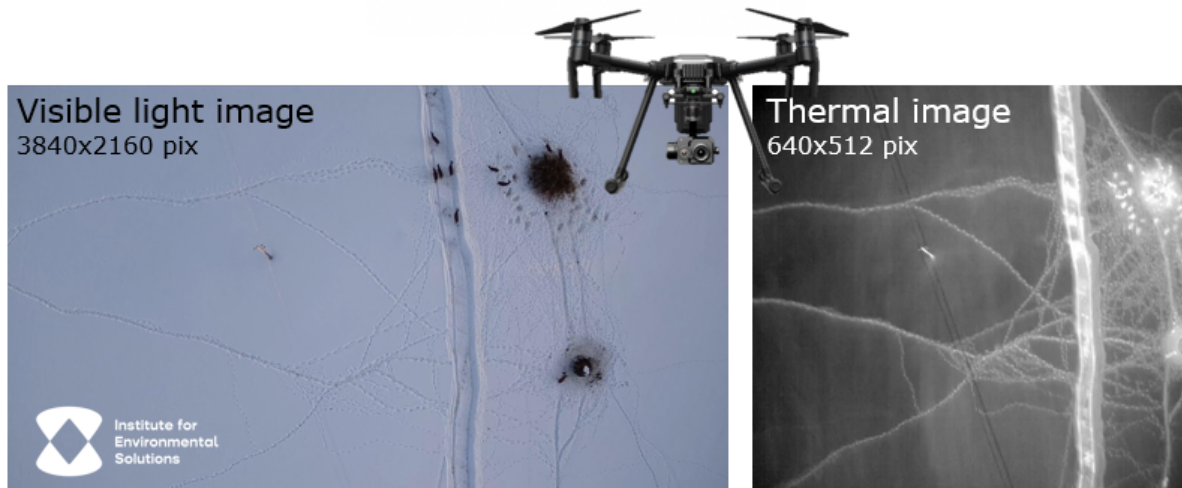


Figure 1. Image example of red deer

It was estimated that the drone-based survey of 100 ha large territory is ~10 times less time-consuming than traditional field surveys. However, current drone technology is limited to reliable monitoring of only large ungulates (e.g., elk and red deer) and relatively open territories.

New biologging approach for long-term tracking and characterizing behaviour in free-roaming wild boar

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Long-term tracking is one of the most important methods for studying animal behaviour. Scientists are developing more and more sophisticated devices for tracking during the last decades, but continuously long-term tracking and detailed behaviour description have not been possible yet. Here we take advantage of the emergence of biologging technologies to characterize the adaptive significance and biophysical mechanisms underlying analyses in free-roaming wild boar (*Sus scrofa*). We have designed biologging collars equipped with tri-axial accelerometer and magnetometer sensors and GPS tags. Accelerometer data from a subset of individuals was synced with ground-truth video records to develop and test behavioural classifiers using machine learning techniques. Classification performance from individuals not used to train the classifier shows that the model has a precision of 88% and recall of 84% across five common boar behaviours. Behavioural classifications were then time-synced with magnetometer and GPS data to provide a detailed record of magnetic headings and the global position of free-roaming boar. A preliminary analysis combining behavioural classifications, magnetic headings, and GPS positions gives us detailed information about animals' lifestyles. Furthermore, the continued development of these technologies and techniques will offer new opportunities to investigate a range of important biological and ecological topics.

Monitoring breeding Eurasian curlew by thermal camera drone vs traditional ground observation: advantages and limitations

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The Eurasian curlew, *Numenius arquata*, is in steep decline in Europe and France, like many other meadow shorebirds. In France, the main breeding population comprised about 700 pairs in 2010 (i.e. nearly 40% of the national breeding population). It is located in the east of the country in the grassland areas of the Saône Valley (8,000 ha stretching over approximately 350 kilometres) with very contrasted local dynamics. It is essential to precisely locate the nesting areas and understand the parameters likely to affect the breeding success (predation, early mowing, spring flooding). In such a vast sector, methodological choices are crucial. Therefore, in the spring of 2021, we tested two monitoring methods: classic ground monitoring by observation with binoculars and the use of a thermal camera drone.

The objective of this exploratory study was threefold since it involved (i) comparing two monitoring methods (advantages and disadvantages), (ii) precisely locating the nests and (iii) defining a methodology that could be reproduced in time and space for monitoring the breeding curlews.

This monitoring was carried out from April to June 2021 on 6 grids of 1 km² (randomly selected) where the Curlews regularly breed. Every week, the same observer counted all the pairs of Curlews showing reproductive behaviour. A first attempt by drone with thermal detection happened in mid-April on these same grids, which made it possible to locate the main nesting sites and the first nests (egg counts). Another drone monitoring session, carried out in mid-May, was intended to confirm these installations.

This survey made it possible to assess the error of detection and location obtained by the ground monitoring method. By testing different flight parameters of the drone (speed, altitude), it was possible to optimise the detection of Curlew nests while limiting disturbance. Similarly, it was possible to differentiate between confirmed breeders (eggs and/or chicks) and probable breeders (on-site courtship or breeding behaviour only).

Our study shows that ground counting and drone use are complementary techniques allowing good detection of nests. This is an essential asset for implementing protection measures, particularly during early mowing.

Possible predator birds of Wood Pigeon nests recorded by camera traps in an urban environment

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Predator control in urban areas is an essential yet sensitive subject in wildlife management. This research aimed to document and record the possible nest predator birds of Wood Pigeon (*Columba palumbus* L.) nests in urban habitats. Since the urbanisation process of this species is still ongoing, the identification of potential risks, the effect on the breeding success of this bird is needed.

Camera traps in Debrecen, Hungary, recorded the cases of predations. This method was used to follow the breeding phenology of urbanised pigeons and doves, but on the other hand, the predation pressure of birds was also documented. The applied camera traps were Forestcam LS-880 type with a solar accessory for longer battery life. The camera capture settings were set to 3 photos and a 10-second video. Surveys started in 2017 as part of an artificial nest predator monitoring, and then in 2020, camera traps were deployed on Wood Pigeon nests at several locations.

After placing the cameras on artificial nests, approx. 18,000 exposures were evaluated. A significant part of the images is irrelevant to the research, considering the constant change of the environment (air movement, leaf movement, precipitation). However, between the recordings, we also recorded a still and moving image confirming our prediction, i.e. the nest predation by the Hooded Crow.

In the second case, there was a Wood Pigeon nest in an enclosed garden area. Two nestlings hatched successfully; however, a Magpie (*Pica pica*) destroyed it and later carried away the carcasses of the chicks. The returning parent tried to heat the already lifeless chicks and then left the nest. In our third case, camera traps were placed at a Wood Pigeon nest on a Small-leaved Linden. There were two eggs in the nest that a Jay (*Garrulus glandarius*) has found first and broke them open. Later, the remains were consumed by Starlings (*Sturnus vulgaris*).

Despite their short expositions, these case studies revealed an urgent need for urban wildlife management since the predation caused by crows can lead to the massive degradation of urban bird communities. Besides in big-sized birds such as pigeons and doves, crows can cause fatal damage in songbird populations. As a novelty, the nest predation of the Common Starling on open nests has not been documented so far in Hungary. However, its subspecies native to the Azores has been described as the primary egg predator of the Roseate Tern (*Sterna dougallii*). It is also known from international sources that the starling usually breeds in the natural or artificial nest, which, if occupied by other bird species, destroys its nest, regardless of its stage of development (eggs, flaky or mature chicks), but does not consume it, even intraspecific infanticide was observed.

Use of baiting sites by wild boar in an urban environment, Budapest

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Keywords: *Sus scrofa*, camera trap, urbanisation, supplementary feeding, hunting, corn, non-target species

The urbanisation of wild boar (*Sus scrofa*) appears in different continents, from smaller villages to big cities. In the capital of Hungary, Budapest, this process is also well identifiable. Urban wild boar can cause rooting damage in parks and gardens and be dangerous to humans or their dogs. Management of this situation is not easy; one of the solutions can be the effective hunting of the species at baiting sites at the town's boundary. We investigated the appearance of wild boar and other mammals and birds and the time spent at the baiting sites during two consecutive periods, between February and May and June and November, in 2019, respectively. Camera traps were used at 6 different places in both intervals. Remote sensing cameras were set up to collect photos of appearing animals continuously for a range of days between 11 and 100 per site per period.

On average, wild boars appeared at the baiting sites on 25% of the study days, but this value could increase to two-third of the days or decline to 5%. That is, we detected wild boars on average every 3 or 4 days, which could be on consecutive days or even just after 3 weeks. They appeared in the vast majority in the dark, and an average of 10 pictures were taken of them at a place per day. The observed group size ranged from solitary individuals to 19 individuals.

The utilisation of baiting sites by wild boars at the periphery of the urban zones can be considered relatively frequent. Other non-targeted species (mainly roe deer, red fox, badger, stone marten, dogs and cats and small passerine species, magpie, jay, pigeons, and pheasants) can also benefit from the supplemented corn and small animals moving on them. However, to be able to control the urban wild boar population, the effectiveness of hunting should be maximised at these places to outweigh the potential non-intended positive effects of readily available corn bait.

Space use of European mouflon: results of a preliminary study in Mediterranean Croatia

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Keywords: Bovidae, GPS telemetry, movement ecology, *Ovis aries musimon*, ungulates

In this study, we analysed telemetry data from GPS monitoring of the European mouflon *Ovis aries musimon* in two areas of the Mediterranean region in Croatia. Four males were collared on the island of Dugi Otok (43°56'44.5"N 15°07'30.0"E), while two females and one male were collared on the mainland coast near the town of Senj (44°59'31.2"N 14°54'54.7"E). GPS collars programmed to take 24 locational fixes per day were deployed on seven European mouflons to provide insights into their space use. The study period was divided into two seasons - winter (January - March) and spring (April - June). The results showed that home ranges of the island population (IP) were considerably smaller than those of the mainland coast population (MP) in both seasons: 294.78 ha ± 153.34 ha for IP and 440.28 ± 31.45 ha for MP in winter, and 168.66 ha ± 60.33 ha for IP and 326.76 ± 62.69 ha for MP in spring (based on Minimum Convex Polygon method). The daily range value was estimated as 1.59 ± 0.31 km/day for IP and 2.49 ± 0.72 km/day for MP in winter, and 1.41 ± 0.22 km/day for IP and 2.81 ± 0.94 km/day for MP in spring. A possible reason for the larger seasonal home ranges of MP individuals may be explained by the presence of large predators and higher anthropogenic pressures on the mainland coast, such as hunting pressure and proximity to urban areas. In addition, variation in daily ranges among populations may be explained by food-dependent movement behaviour driven by differences in resource availability between two habitats. However, to obtain more precise daily range values, a higher sampling frequency of GPS collars is needed to increase the precision of population-specific daily range estimates. Further analyses should be conducted with a larger sample and include natural and anthropogenic covariates, such as resource availability and predation, that may potentially influence the movement ecology of European mouflon.

Winter feeding strongly affects habitat selection of red deer in a mixed landscape

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In Denmark, massive provisioning of artificial food supply (carrots, beets) is a common practice by landowners to attract red deer (*Cervus elaphus*) and thereby increase hunting opportunities

in the hunting season. Some landowners may also feed ‘their’ deer to keep them in good shape through the winter. In other cases, feeding is done to prevent damage to cultivated fields or forests. As feeding sites of hundreds of kilos of food represent an overabundant food source of high caloric values, this food provisioning in winter may potentially influence the spatial distribution of red deer in the landscape as a significant energetic pull factor. Consequently, grazing pressure in nature types reliant on ungulate grazing, such as nearby heathland, may be reduced. We analysed habitat use and habitat selection by red deer in a mixed Danish landscape, consisting of a protected heathland, farmland and forest (conifers) of four GPS- tagged hinds, during an observation period of 719 days (~ 2 years). Faecal pellet counts on transects in a different direction from the feeding sites were used as an independent measure of habitat-specific deer activity in the cold season (October-April). Faecal pellet counts were higher in heathland than in other open land cover categories and within 60 meters from the sites. Habitat selection analysed from GPS positions varied seasonally; however, the forest was always selected compared to heathland, grassland and arable. Cross-individual analysis showed a preference for proximity to feeding sites during winter and spring(weak) and avoidance the remaining year. In conclusion, we found strong indications that supplementary feeding plays a central role in shaping the spatial distribution of red deer in the cold season, as red deer strongly selected for adjacency to these feeding locations during winter. As a consequence, the grazing intensity on the heathland might be reduced accordingly. Local consensus exists that the red deer population should be reduced to minimise crop damages in the warm season. Therefore, supplementary feeding should be given increased attention in future management plans, as winter feeding serves no constructive purpose for the local farmer’s common good.

Habitat selection and diel activity patterns of wolves and red foxes in a Danish wolf territory

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Top predators regulate species communities through top-down trophic interactions or through the *landscape of fear* by modifying mesopredators' behaviour and activity patterns. Thus, the absence of top predators can lead to mesopredator release. The first grey wolf (*Canis lupus*) in 200 years was documented in Denmark in 2012. In the absence of wolves, red fox (*Vulpes vulpes*) has been the largest canid species in the country. This study investigates the extent to which habitat selection and diel activity patterns of red foxes correlates with local wolf activity within Denmark's first wolf territory using wildlife camera monitoring. We used data collected in the national wolf population monitoring program with camera traps across three years (10 January 2017 -5 January 2020: 7613 camera days resulting in 658 wolf observations and 879 fox observations) from 89 camera locations inside the Ulfborg territory, Western Jutland in Denmark (ca. 50 km²) A wolf pair established territory in autumn 2016, reproduced in 2017 (8 pups) with the pups residing until spring 2018 where the last parent disappeared. A single wolf held the territory until a new mate arrived in November 2018, giving birth to a second litter (six pups) in 2019. Wolf activity level (index) was quantified using a kernel density estimator in 6-

month intervals, using verified wolf observations (scat and camera traps) as observations. We modelled local wolf and fox abundance as the number of observations per camera day as a function of the season (three-month categories) and landscape variables (distances to roads and buildings, vegetation height within 25 m from the camera positions). For foxes, we also included the local wolf activity index and wolf presence as a predictor. Further, we investigated if periods with high or low wolf activity levels influenced the diel activity patterns of foxes. Wolf observation frequency (observations/camera day) correlated negatively with vegetation height. The observation frequency of foxes was best described by a model including distance to nearest house (negative correlation). In contrast, models including activity and presence of wolves were not better at explaining the presence of foxes than the distance to the nearest house. Temporal activity overlap between fox and wolf were not significantly different in periods with high and low wolf activity levels. The results suggest that wolves selected for high vegetation density in this single wolf territory, whereas foxes selected for proximity to buildings. We found no apparent effects of local wolf activity on neither spatial nor temporal activity patterns of foxes. Hence, either foxes ignored wolves or attraction counterbalanced avoidance (risk-sensitive foraging). No matter which behavioural mechanism in play, the emergent pattern indicates no measurable spatial effect of wolves on fox activity patterns in space or time.

Electromagnetic field as a physical factor changing the physiology of the European roe deer reproductive system - in vitro studies

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Purpose: Roe deer is a species sensitive to changes in the surrounding environment. A clear seasonality of reproduction characterises it. The electromagnetic field (EMF) is emitted by devices used for the transmission and distribution of electricity. Along with the increase in the number of electricity consumers, it is necessary to expand the energy infrastructure. More sources emitting EMF are created near the roe deer habitats, so they are subject to its influence. The study aimed to investigate whether EMF influences the level of steroidogenic enzymes and steroid hormone receptors in various physiological states of the male roe deer testicular tissue *in vitro*.

Material and methods: The testes of male roe deer (n=8) were tested. They were hunted in the forests of the Kolbuszowa Forest District in Podkarpacie Region (Poland) following the Polish Act on the Protection of Animals. After transport to the laboratory, pieces of testes were transferred to a culture well with the medium. The culture was carried out in a water bath under an atmosphere of 5% CO₂ and 95 % O₂, at a temperature of 34 °C. The testicular tissues were incubated under the influence of EMF (Astar generator, Poland) with a magnetic induction of 8 mT and a frequency of 50 or 120 Hz for 2 or 4 hours. After incubation, tested and control tissue (incubated in the same conditions but without EMF) were frozen in liquid nitrogen and then stored at -80 °C for protein isolation for Western Blot analysis or fixed in paraformaldehyde histological and immunohistochemical analysis.

Results: Examination of the presence and amount of 3β -HSD enzymes and aromatase by immunohistochemistry showed different immunopositive reactions dependent on the time of interaction and frequency of EMF. EMF influences the levels of 3β -HSD and aromatase enzymes in a time-dependent and frequency-dependent, and period-dependent manner. Western Blot analysis showed an increase in the level of aromatase in tissues treated with 50 Hz EMF for 2 hours during the rut period, as opposed to the post-rut period, where under the influence of the same EMF parameters, there was a decrease in the amount of protein. Tissues from pre-rut and rut periods after the exposition to EMF for 2 or 4 hours showed a reduction in ER-beta. Conclusion: Reproductive disorders are a severe problem. EMF affects the level of analysed steroid receptors. Changing the level of steroid receptors in the deer testes may cause disturbances in spermatogenesis, lead to impaired reproductive function, and in the post-rut period, by increasing the level of AR and ER-beta receptors, prolong the period of reproductive activity. Steroid hormone receptors are ligand-dependent nuclear transcription factors responsible for, among other things, the correct course of the spermatogenesis process. A decrease in the level of these receptors could result in abnormalities in sperm production and, consequently, reproduction.

Long-term trend in the chamois (*Rupicapra rupicapra*) population in the Bavarian Oberallgäu region

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Keywords: count data, hunting bag, sex ratio, chamois

Objective: Because of climate change and the fact that the chamois is now listed under the “near threatened” category in Germany’s Red List of Threatened Species, the situation of the chamois in Germany is currently the subject of heated debate. Data on the chamois population is based on the hunting bag, which can only be used as an indicator of trends in the population if there is no change in the intensity and effectiveness of hunting measures within the observation period (Begon et al. 1996).

Methods: For the district of Oberallgäu, count data going back to 2014 is available in addition to the hunting bag data. From 2004 onwards, the hunting bag data also shows the exact age of the animals so that it is possible to carry out a cohort analysis.

Results: Since 1998, the number of chamois shots has been decreasing, while the proportion of animals found dead from other causes has increased. According to our cohort calculation, the population consisted of 2969 chamois in 2004, of which 485 were fawns. There was a gender ratio of 1:0.66, biased towards the bucks. From 2016 to 2018, a gender ratio among yearlings was calculated from one buck to 0.8. The count data from the last few years shows a population

of approx. 2779 chamois, including 667 fawns, with a sex ratio of 1:1.69 in favour of the does. If we assume a balanced sex ratio, we arrive at an average population of 3175 chamois. If we adjust the sex ratio to match the hunted yearlings, the population amounts to 3418 chamois. This value is consistent with the estimate made by the professional hunters. Despite the falling hunting bag, the chamois population in the Oberallgäu region can be said to be growing. This is consistent with the population structure and the key indicators from the cohort analysis. Conclusion: The example of the Oberallgäu region shows that for a discussion to be neutral and objective, two independent data sets are necessary.

Genetic structure of European brown hare (*Lepus europaeus*) in Central-Europe with focus on Carpathian-basin

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The brown hare (*Lepus europaeus* Pallas, 1778) is a widely distributed small game species throughout Europe; however, its population size has experienced a dramatic decline in most of the European countries, including Central Europe with the Carpathian Basin. The Carpathian basin has been described as a refugial area for several species like red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), common vole (*Microtus arvalis*) etc. However, only a limited number of genetic diversity and structure studies were performed on brown hare from this region.

To characterise the population structure of brown hare in Central-Europe with a focus on Carpathian-basin, we sequenced 426 bp length of mtDNA cytochrome *b* (cyt *b*) of 175 brown hares (Hungary, Serbia, Poland, Romania). To extend our knowledge, brown hare sequences from Genbank from five other European countries (Poland, Austria, Germany, France, and Bulgaria) were also included in the analysis.

Bayesian clustering analysis of Carpathian brown hares and other brown hares was implemented in BAPS v6. Fifty haplotypes were detected, and they belonged to three haplogroups (Anatolian/Middle-Eastern-AME, South-Eastern European-SEE and Central European-CE). Carpathian brown hares belonged to each haplogroup. Three clusters (K = 3) were detected from the Carpathian basin, corresponding to the three haplogroups. Between

haplogroup, genetic differences were calculated, as indicated by pairwise ϕ_{ST} estimates and the estimated number of migrants per generation (N_m) for each pair of brown hare haplogroups. Pairwise ϕ_{ST} values ranged from 0.582 (CE vs SEE) to 0.824 (AME vs CE). Gene flow estimates (N_m) derived from ϕ_{ST} ranged from 0.107 to 0.359. All brown hare haplogroup pairs were significantly differentiated from one another. The isolation by distance test revealed that genetic distance was significantly correlated to the geographic distance for total haplogroups ($R^2 = 0.032$; $p < 0.01$).

In conclusion, we confirmed the unique location of the Carpathian basin with the presence of both subclades (CE and SEE) of brown hare belonging to the lineage EUR in Hungary and Serbia. Whereas haplotypes belonging to SEE are predominant in Southern and Central Serbia, the unique sequences of CE are predominantly found in Hungary and Northern Serbia. We discovered large contact zones for brown hares in several countries of Central-Eastern Europe.

SOTKA project to reverse the trend in declining waterbird populations

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Keywords: Biodiversity loss, Waterbird, Wetland, Restoration, Invasive Alien Predator

Finland is responsible for the breeding success of many European waterfowl species and, through this, for their population trends. The mallard is the only one with a stable population trend of the ducks, while all other game duck species show a declining trend alongside many non-game duck species.

What is particularly alarming is the decline in breeding success. The decline in habitats is likely to be the main reason for this. Eutrophication and the increase in cyprinid fish species have been identified as plausible causes. Besides this, the numbers of predators that pose a threat to nesting birds have been growing during the last decades. Especially two invasive alien predators, the American mink (*Neovison vison*) and the Raccoon dog (*Nyctereutes procyonoides*), pose a significant threat to ground-nesting waterbird communities.

SOTKA project lead by the Ministry of Agriculture and Forestry, Finland, is part of a more extensive HELMI program that aims to halt biodiversity loss on many habitats. The measures aiming to help water birds are: restoration of NATURA 2000 SPA bird lakes, building and restoring wetlands, creating a network of resting areas for autumn migration and an extensive invasive alien predator control on all restored areas. Targets are set for 2030, but already by 2023, the restoration of the SPA lakes will be supported by effective predator control on 60 lakes and their surroundings, 40 (equalling to 500 ha) new wetlands will be built, and the resting area network will comprise of at least 25 suitable quality wetlands. With these measures, the Government of Finland aims to halt and reverse the declining trend of water birds. All actions taken are monitored carefully and documented, enabling a scientific evaluation of the

effectiveness of the methods. HELMI program is a joint program of the Finnish Ministry of Agriculture and Forestry and the Ministry of the Environment.

The GECISO standard: a certification proposal for sustainable hunting

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Game species are elements of the wildlife of a region. As such, they suffer the effects of human activity on ecosystems, but in their case, in addition, they may suffer impacts due to hunting and game management. During the last decades, game management has been experiencing a trend towards intensifying interventions on populations and their habitats. Many of these practices are not compatible with the conservation of natural values. From various sectors, both scientific and conservation, and hunters and game managers, these risks are warned that undermine the activity itself and compromise conservation. Faced with these facts, some public administrations with hunting competencies in Spanish regions include in their hunting regulations the possibility of a quality management certification aimed at promoting a more sustainable game management. From the scientific field, work has been carried out on this topic to develop a technical standard (GECISO) for the territorially based certification of game management by companies accredited by ENAC, the Spanish National Accreditation Body. GECISO provides detailed regulatory specifications for the certification of sustainable management, and it is beginning to be translated into practice on hunting grounds in Spain.

Roe deer and red deer activity correlate negatively with wolf activity in a Danish wolf territory

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Predators can affect prey species' spatial distribution and behaviour by creating a *landscape of fear* (LOF), where prey avoid areas associated with high perceived predation risk and increase vigilance in risky areas. LOFs created by returning predators have been theorised to cause behaviourally mediated trophic cascades in areas where predators have historically been absent. However, the evidence for these cascading effects has been disputed, especially in areas with a high degree of human disturbance. Therefore, the first point would be to investigate the extent to which predator presence influence spatial distributions and behaviours of their prey at all. Grey wolf (*Canis lupus*) populations are presently recovering in Europe, emphasising the need for studies on predator-mediated changes in prey behaviour in anthropogenic landscapes. Using

wildlife camera monitoring, we studied how spatial variation in wolf activity within a Danish wolf territory affects spatial and diel observation patterns and vigilance behaviour of roe deer (*Capreolus capreolus*) and red deer (*Cervus elaphus*). We analysed camera trap data spanning three years (2017-2019: 7613 camera days) at multiple locations inside the Ulfborg wolf territory in Denmark (c. 50 km²), where wolves were established in 2016. For each site, an index of wolf activity was estimated using a kernel density estimator and verified wolf observations from the area (from camera traps and scat finds) for periods of six months. We quantified local deer abundance/activity as the number of deer observations per camera day and alertness as the proportion of observations where the deer were clearly observant. We modelled these response variables as a function of seasons, landscape variables and the local wolf activity index.

Furthermore, based on the timestamp on observations, we quantified diel activity and the overlap in diel activity between wolves and deer in high and low wolf activity areas. After adjusting for seasonal variation and landscape variables, the number of observations per day of both deer species correlated negatively with the wolf activity index. We found no indication that an increase in wolf activity increased deer vigilance; instead, roe deer lowered vigilance due to increased wolf activity. Temporal overlap in activity between deer and wolves did not vary between high and low wolf activity areas, signifying that deer did not respond to increased wolf activity by avoiding wolves in time. This case study suggests that roe deer and red deer may either prevent or reduce their activity level in those areas within wolf territories where the activity of wolves is highest. High wolf activity, however, did not appear to influence alertness or diel activity patterns, indicating that presence of wolves had limited influence on prey vigilance and diel activity patterns.

Promoting coexistence of humans and wolves in Finland

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Keywords: coexistence, collaboration, information sharing, livestock damage prevention, large carnivore management, rural areas, wolf

Objective: Although the wolf is a threatened species in Finland, its coexistence with people often causes concerns, fears and losses of domestic animals. Reaching a vital wolf population is a challenge if people feel that they cannot coexist with wolves. The LIFE BOREALWOLF project (2019–2025) aims to improve coexistence by reducing negative impacts associated with the presence of wolves. For example, the project provides tools to prevent adverse effects of wolves and promotes interaction and collaboration among territory residents.

Methods: The LIFE BOREALWOLF project interacts with local people in several ways. The project helps farmers to protect livestock from wolf depredation. It provides tools, guide materials and face-to-face consultation, especially on farms located in wolf territories. The

project supports the uniquely extensive network of trained volunteers that confirm large carnivore observations and collect wolf DNA samples that form the backbone for population estimates and management. It assists the network in the field and provides training materials. The project develops the framework of territory cooperation groups, where local stakeholders convene to discuss the wolf situation and plan for beneficial regional actions. It attends meetings, organises seminars and actively distributes wolf-related information to the cooperation groups and the public.

Results: During summers 2020–2021, LIFE BOREALWOLF provided 22 farms with electric fences to protect their livestock (ca. 50 km). In addition, trail cameras, deterrents, and GPS collars were lent to some 40 farms. A total of 7 000 animals (mainly sheep) received increased protection, and the work continues. Testing these devices in practice provides essential experience, as many of them have not been largely used in Finland. Livestock owners have been happy to collaborate and receive hands-on guidance. During the DNA-sampling season of winter 2020–2021, volunteers' increased support and training yielded a record quota of 1 499 samples from 278 individual wolves. The local territory cooperation groups actively supported sampling. A guidebook for large carnivore observers was published in 2021.

Conclusion: Opportunities for locals to participate is the key to successful management. To engage the people living on wolf territories, it has proven highly important to meet them face-to-face. Gathering large carnivore observations by volunteers and forming territory cooperation groups can be recommended as management tools for other countries where conflicts arise from wolf presence. Well-functioning cooperation between territory residents, large carnivore observers and relevant authorities ensures that wolves are comprehensively monitored, wolf depredation is being actively prevented, and people have access to reliable and up-to-date information about wolves.

On the use of population reconstruction in mouflon: Opportunities and weaknesses

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This study analysed the reliability of the reported mouflon population size in the spring, using data available for Borsod-Abaúj-Zemplén and Heves county and national recordings. We analysed the period between 1994-2010 by applying population reconstruction using trophy scoring data. Based on the results, we divided the whole set into two parts (1994-2002, 2003-2010). After that, we compared the results of our population reconstructions with the reported mouflon population sizes. The population-reconstruction method allows us to provide information about a population (sex ratio, age composition) years after the data collection. The most significant benefit of this method is that we use the number of age classes of scored trophies, which means that there is no need to rely on the data reported by game managers

exclusively. During the reconstruction, we used the corresponding data throughout multiple years of calculations, which results in less fluctuation regarding the outcome (reconstructed population). This also results in a high expected correlation between the number of hunted individuals and the reconstructed population's size. This decision relied on the fact that every single one of the studied territorial units deviated from the expectations in 2002.

In conclusion, we can say that Borsod-Abaúj-Zemplén county and the national reports reveal similar patterns of population dynamics. Meanwhile, Heves county's differs from the previous counties meaning that the number of shot males and scored trophies were too different. It is a clear indication that the data set did not include all trophies.

Society's management perceptions and preferences of the Iberian ibex in Sierra de Guadarrama National Park (Spain)

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Iberian ibex is present in the Sierra de Guadarrama National Park since the 90s (after its reintroduction with 67 individuals). Since then, the population has been growing (it exceeds 5,000 individuals) and is causing damages to the ecosystem's ecological values and the species itself, which have been revealed after exhaustive monitoring of the Park. Therefore, it is urgent to design a short- and medium-term management plan that contemplates wildlife managers acting accordingly in the Park. A discrete choice experiment that considered various ecological and management scenarios was conducted of three population samples: 430 on-site visitors, 210 off-site visitors and 210 non-visitors, and two levels of status quo information were also considered. This approach quantifies citizens' preferences regarding the ecological and management scenarios of the National Park, which are fully described in an already published article in the journal *Science of the Total Environment* (2021, number 776). The main results were that visitors and residents of the area stated that the ibex must be managed in the Park. What is more, no ibex management would produce a loss of well-being higher than the Park's annual budget. If the ibex management plan was not successful, how it was done became more important. Live capture and culling were accepted if the results of the program were effective. The definition of the status quo had no significant effects on preferences. Quantifying conflicts related to population control while informing about the consequences of the ecological and management scenarios could inform policymakers and help them in the design of management programs since the success of a management tool is often conditioned by the acceptance of the techniques used and by the collaboration of the agents involved (for example visitors).

Can earthworms indicate the burrow site selection of the European badger in forested areas?

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Due to the widespread occurrence, the European badger and the red fox have a vital role in most of the ecosystems of the Carpathian Basin. Thus they have also great importance in wildlife management and nature conservation. Therefore the development of management based on their biological knowledge is a relevant task. It is fascinating to answer how can these species divide such necessary and commonly used resources (e.g. the potential burrow sites) with similar habitat use.

Motivated by the insufficient knowledge of the European badger and the red fox in Hungary, the primary aim was to collect data about the habitat selection and the burrow site competition of these species.

The study area is located between Gödöllő and Valkó, in the Gödöllő Hills. Its size is 3728 ha and is mainly covered by forests (96%).

Three methods were used during the study. At first strip transect method was implemented to find the burrows. Eighty-one burrows were found in total; badger and 14 used 14 by red fox. Both species occupied two burrows; therefore, the data of these burrows were excluded from further analysis.

The second method was the earthworm density and biomass measurement. Eight samples were taken per burrow, which means 224 samples in total. If a new burrow was found during the earthworm measurement, it was also involved in the study (the final number of burrows: red fox: $n = 14$, badger: $n = 21$). After the field measurement, the earthworm samples were sorted into groups based on the main tree species, the age of the forest and the soil conditions. The earthworm density and biomass of these groups were compared. The third step of the study was the completion of an earthworm map in QGIS. In this case, the forested areas were ranked based on the results of the second method. After the ranking, the forested areas were sorted into four earthworm habitat categories („1” is good habitat, „4” is poor habitat). In the last step of the analyses, the red fox and badger burrows were sorted by the distance from the „1” category in two groups, which are the „Closer than 400 meters” and the „More than 400 meters away”.

Comparing the distribution of burrows, a significant difference can be found (Fisher's exact test, two-sided: $p = 0.039$, $n = 35$). 90% ($n = 19/21$) of the badger burrows were located closer than 400 meters from the „1” earthworm habitat category, while in the case of red fox lower proportion can be seen (57%, $n = 8/14$).

This result is in line with those of the previous studies, which have shown the importance of earthworms in the diet of badgers. Further studies are necessary to test this possible correlation in more detail and on a larger scale.

Estimation of *Clostridium botulinum* prevalence in wild waterfowls in France

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Keywords: Wild avifauna, botulism, prevalence, healthy carriage, exploratory approach, bioavailability

Botulism is a disease that can cause thousands of deaths in wild birds but can also affect livestock and humans. *Clostridium botulinum* produces neurotoxins called BoNTs, which cause a flaccid paralysis characteristic of botulism. As the pathogenesis of avian botulism in waterfowls is still poorly understood, in this study, we wanted to 1) estimate the healthy carriers rate and its potential role in an outbreak; 2) determine the prevalence of *C. botulinum* and its BoNT type in birds' tissues after an outbreak from a sanitary risk perspective concerning the consumption of meat from hunted birds.

To answer the first question, the prevalence of *C. botulinum* in two waterfowl species was estimated by cloacal swabbing in three study sites, one with outbreaks and two with no recorded outbreak. In another place, where an outbreak occurred, the prevalence of *C. botulinum* in different organs was estimated from a sample of hunted waterfowls to address the second objective. We detected only 1 positive case in the site where an outbreak occurred (N=60) (Table 1), suggesting a very low cloacal carriage on apparently healthy birds, whatever the place. On the contrary, detection of *C. botulinum* was higher in the caeca of hunted birds when compared to cloacal swabs and the other analysed organs. It was noteworthy that one keel muscle was positive for BoNT E, using PCR (Table 1). To conclude, low prevalences estimated on three sites, including one with botulism outbreaks, coupled with the detection of a single positive case, are not favouring a reservoir for the waterfowls. Furthermore, the confirmed case of a mallard duck, whose keel muscle was positive for *C. botulinum*, showed the importance of communicating recommendations on wild birds' meat consumption during botulism outbreaks. As a perspective, the bioavailability of *C. botulinum* and/or BoNTs in the environment seems to be a crucial issue for a better understanding of the mechanisms of infection of wild birds by *C. botulinum* pathogenesis.

Table 1: Prevalence of positive swabbed banded birds of the Lac du Der (where an outbreak occurred), Grand'Mare and Baie de l'Aiguillon and of positive caeca of hunted birds in the Grand Birieux (where another outbreak occurred – swabs and caeca are supposed to give similar results). In columns 2 and 4, the first number corresponds to the total number of swabbed banded birds or caeca. The second number corresponds to the number of positive cases among all banded birds swabbed during the given period or among all the caeca analyzed. A cross was put when not enough data (N<10) was available to estimate.

Analysis	Site	Period	Sampled ; positives	Credible interval (80%)
Prevalence - Healthy carriers	Lac du Der (88;1)	Aug/Sept 2018	60;1	0.87 - 6.2%
		Nov 18	8;0	X
		Jan 19	1;0	X
		Aug/Sept 2019	13;0	0.75 - 15.2%
		Aug/Sept 2020	6;0	X
	Grand'Mare (19;0)	Sept 18	2;0	X
		Nov/Dec 2018	10;0	1 - 18.9%
		Jan 19	4;0	X
		March 2019	3;0	X
	Baie de l'Aiguillon (40;0)	Dec 2018	8;0	X
		Jan/Feb 2019	28;0	0.36 - 7.6%
Nov/Dec 2020		4;0	X	
Prevalence - toxin types	Grand Birieux (29;5, C/D)	Nov 18	29;5	10.9 - 28.7%
	Grand Birieux (29;1, E)	Nov 18	29;1	1.79 - 12.4%
	Grand Birieux (29;6, total)	Nov 18	29;6	13.5 - 32.5%

Forage quality of current and previous year interact to affect body condition, reproductive rate and phenology in Iberian red deer

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Body condition for reproduction in capital breeders such as the red deer (*Cervus elaphus*) is mainly determined by their stored energy reserves. Thus, environmental conditions and resource availability may affect reproductive performance and breeding success. In warm Mediterranean regions, current climate change is driving to a hotter and drier scenario that is expected to affect the biology and dynamics of many populations. We were interested in the impact of these local climate variations on red deer body condition and the relationship with female reproductive phenology and breeding success. We used satellite information and a 25-year data series collected by direct field behavioural observations and sampling during the rutting season in Doñana National Park (SW Spain). We found that poor vegetation availability in drier years was related to the worse body condition of deer (measured by faecal nitrogen content) and a delay in the rutting season. This was associated with lower reproductive rates (as the proportion of females with calves observed the following year). We also evidenced an exciting interaction between conditions of the previous year and the current one on the timing of the breeding season, with the timing of breeding being more delayed when the last year was good and many females bred. The current one was poor, and females hardly recovered

condition. These findings highlight the carry-over effect of reproduction in capital breeders and the impact of climate-change conditions on red deer breeding.

Ecology of freshwater invertebrates and their potential role in the annual cycle of the Northern Shoveler *Spatula clypeata* in the Marais Breton and the Marais Poitevin (Vendée, France)

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Keywords: *Anas clypeata*; Northern shoveler; freshwater invertebrates; prenuptial period; feeding; habitat

Purpose/Objective: The wetlands of Vendée (France) host the majority of Northern Shoveler *Spatula clypeata* breeding in France [1]. The size of wetlands would influence the abundance and diversity of birds [2]. However, other factors are required for successful waterbirds reproduction, such as accessibility and availability of food resources [3]. Zooplanktonic crustaceans are the main prey of shoveler throughout the year [4] and are captured primarily by filtration [5]. The feeding behaviour of the shoveler is considered highly specialised due to its spoon-shaped bill with very dense lamellae [6]. The relationship between shoveler and invertebrate density has been shown [7] but still needs to be explored [8]. The objectives are to understand the abundance, diversity and habitat of freshwater invertebrates in the study area; and study the trophic relationships between the Northern Shoveler during the breeding season and aquatic invertebrates.

Material and methods: For two years (November 2019 to October 2021), we monitored 30 sites in the wetlands of Vendée (France). From August to February, the monitoring frequency was monthly, while from March to July, the frequency was bimonthly. We sampled aquatic invertebrates greater than 200 µm in size with a benthic corer and a plankton net. Concerning Northern Shoveler, 10 and 16 individuals were respectively equipped in 2020 and 2021 with a GPS/GSM transmitter during the prenuptial and breeding period.

Results: The freshwater invertebrate's density in the sediment (fig. 1a) increased in winter and decreased in summer. Weather conditions can explain this drop-in density (increased air and water temperature, reduced rainfall, temporary drying out). However, pumping and some summer precipitation presents the peak in May - June. In winter and summer, the major taxa in the sediment were identical. The freshwater invertebrate's density in the water column (fig. 1b) fluctuated over the year with three production peaks: December, February to April and late May-early June. Micro-crustaceans dominated the epigeal invertebrates in winter and summer (97% of the pond density).

During the prenuptial period, the feeding behaviour of Northern Shoveler changed over the day. Individuals had high foraging activity during the night and changed site during the day. The selection of breeding sites followed this behaviour. During the night, the area used by the shoveler was characterised by shallow water, aquatic vegetation and high energetic value. The dominant taxa were Cladocera, Insecta and Gastropoda. The day sites were deep, muddy and non-vegetated. These sites were dominated mainly by Copepoda and Amphipoda.

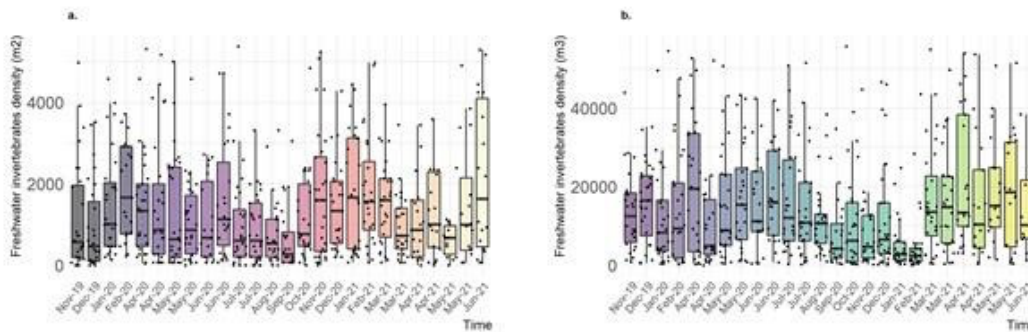


Figure 1: a. Freshwater invertebrates' density in sediment; b. Freshwater invertebrates' density in the water.

Conclusion: This study showed that the freshwater invertebrates density fluctuated over the year. During the prenuptial period, shoveler exploited different habitats during the day according to their activities.

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Spatial and social responses of wild boar to supplementary feeding – an experimental approach

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Food resources are one of the critical factors for an animal to decide how to use space. Natural food resources are not distributed evenly in space and time but more often in patches. Those patches attract animals, creating hotspots of social interactions and influencing their movements. Supplemental food provided by humans to wildlife can be more abundant and predictable for animals than natural resources, changing their spatial and social behaviour. However, the consequences of supplementary feeding on wild boars' movement and social interactions are poorly analyzed. Therefore, an experimental trial with supplementary feeding has been set up in the suburban forest Kostelec nad Černými Lesy (Czech Republic). In total, 22 supplementary feeding sites were randomly distributed in the study area to deliver corn at a low or increased level. After two weeks of standardized feeding at all feeding sites, we manipulated six to eight supplementary feeders to provide an increased level of corn. We analyzed wild boar's movement data of 30 wild boars between 2020 and 2021, collected from GPS and bio-loggers collars fitted to wild boars. We expected that supplementary food would limit movements and ranging towards active supplementary feeding sites. Furthermore, spatiotemporal heterogeneity in supplementary feeding is expected to induce behavioural adaptations, such as range shifts or higher visit frequency at rich feeding sites. Combined with the existing GPS datasets, the analysis will enable a thorough description of individual behavioural responses to anthropogenic activities.

Improving human co-existence with large carnivores (LC) is considered necessary for reaching one of the goals of the EU Council Directive on the conservation of natural habitats and of wild fauna and flora (1992).

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Keywords: large carnivore, Europe, stakeholder analysis, stakeholder mapping

We conducted systematic participatory and transdisciplinary primary research in 14 European countries. The research design consists of three phases: stakeholder identification (Phase 1), participatory stakeholder-mapping (Phase 2a), a comparative network analysis (Phase 2b), and

an Individual Stakeholders' Perception Survey (Phase 3). We use the realistic method based on perceptions of the stakeholders involved. Phase 1 identifies 10 relevant Stakeholder Categories and specific agents. Phase 2a provides distinct comprehensive regional stakeholder maps with a special focus on the quality of multilateral relationships and stakeholders which are not yet actively involved in the networks. Phase 2b concludes with a comparative network analysis. The composition, density, and quality of stakeholder networks as well as the interconnectivity of the project partners differ substantially. We reveal common denominators across Europe, varying relationships between stakeholder categories, and the potential positive role of foresters and veterinarians, for example. Phase 3 provides complementary insights into the involvement of the 10 Stakeholder Categories and their attitudes to large carnivore management. We challenge the perception of distinct stakeholder categories and whether involving institutional representatives in networking activities is sufficient. The results indicate the need for a more comparable implementation of EU regulations at national level, and for regional adaptations of support strategies for distinct stakeholders and networks. Based on current conflict constellations and best practice examples, we conclude with recommendations for strategic stakeholder engagement to: (a) broaden and strengthen the stakeholder networks to (b) improve human-human conflict management in the context of expanding large carnivore populations and their management.

Recreational activities under Covid-19 conditions: solutions for wildlife, habitats and man

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Keywords: red deer, Covid-19 condition, wildlife, recreational activities.

Purpose/Objective: During the lockdown time because of COVID 19 in the first month of 2021 in Germany, people were only allowed to stay at home or spend free time in the open country. After several years, this was the first winter with a snow cover. In North Rhine-Westphalia, with about 18 million inhabitants, i.e. more than 526 people /square kilometres, this led to many conflicts because ski runs and country ski trails were closed, and many people spread all over the areas. In the area of Monschau in the West-Eifel proactive visitor, management was tested. The official ski trails were closed, but at the same time, people were offered reserve trails on the forest roads as an alternative.

Material/Methods: In the West-Eifel winter sports area, Monschau, the effects of cross country skiing on red deer have been under investigation since the 1970s. In 2021 the country ski trails were not prepared – because of Covid 19. The pressure on the habitat of red deer was determined by mapping all footprints and ski trails in the area according to the same methods as in the years before.

Results: Since 2004 the ski trails have run partly through the Eifel National Park. The measures to reduce the pressure on wildlife habitat include the following:

- the provision of qualitatively and quantitatively attractive ski trails, including comprehensive public relations and the periodical closing of certain forest areas
- clearing snow from forest roads only to the minimum amount necessary as an
- alternative when ski trails can't be prepared.

The disturbance-free areas within the habitats have increased from 4 % in 1981 to 25 % or 50 % of the total area since 1987 up to the present day. On the whole, a suitable compromise was found between the legitimate demands of skiers and adequate living conditions for wildlife. The key to success is the participation of all groups and persons concerned.

Even in the Covid, 19-situation people respected the closed areas as in the years before. They stayed on the forest roads compared to other regions, without such a present and effective alternative. Well-prepared forest roads were the key to success.

Conclusion: During the first lockdown because of Covid 19, the region of Monschau in the Eifel was the only one in North rhine Westphalia without more significant conflicts between visitors, locals, the local government and wildlife. It was a great advantage that the people, locals, and visitors from far away knew this concept with official ski trails and closed areas for wildlife for decades.

Current brown hare status in the selected hunting grounds of the Vojvodina region (Serbia)

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This paper focuses on analysing the current trends in the numbers of brown hare in six hunting grounds located in northern Serbia, the Vojvodina region. During the last 40 years, the brown hare population has dropped significantly (over 50%), hunting decreased, and the hare population needs to be closely monitored. The Autonomous Province of Vojvodina has a total of 2,152,695 ha of areas considered as hunting grounds. Besides two low mountains, it is primarily a lowland, flat region. It is regarded as a typical agricultural area with over 83,3% of agricultural land use. To determine the causes for the brown hare fluctuation in these hunting grounds, we analysed the effects of weather variables (mean temperature, maximum and minimum temperature, precipitation), red fox pressure and cull pressure. All hunting grounds have similar areas and habitat conditions but with different hare densities. Data on brown hare were obtained from the Provincial Secretariat for Agriculture, Water Management and Forestry based on hare spring counts from 2012 to 2021. Hunting was carried out throughout the observed period. Data on the fox cull was given since there is no available data on the fox population. However, hunting bags were already proven to be a potential method for monitoring

the fox population. Data on climate variables were obtained from Meteorological Yearbooks published by the Hydrometeorological Service of Serbia. Mean temperature, maximum and minimum recorded temperature, and precipitation was used from local climatic stations. All analyses were carried out using the IBM SPSS (ver. 23). Multiple regression models were applied to assess the relationship between the spring brown hare numbers ($t+1$) and the effects of selected habitat variables. Most hunting grounds showed that hares were affected by high summer maximum temperature and low precipitation in the same period, linked to summer droughts. The mean temperature didn't show a significant effect for all hunting grounds. Low temperatures also didn't seem to affect hares. However, in some hunting grounds, there was a negative relationship with high winter precipitation. The Brown hare population has been influenced by the agricultural intensification of the last century, which was the most probable cause for the initial brown hare decline. The 2009 and 2010 hare decline can be attributed to red fox rabies vaccination and the following rise in the fox population. However, in the last few years, we witness that besides these two factors, drought and extreme temperatures that have become more frequent in the Vojvodina region also affect the brown hare population.

Critical challenges facing the current and future management of ungulate populations and their impacts – a personal perspective [Keynote speech]

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After 50 years as an academic and practitioner, I speculate about the challenges facing those managing ungulate populations and their impacts in the decades to come. While it would be impossible in the time available to do more than skim the surface, I introduce those topics which I think will be of main concern.

Populations of large ungulates are expanding in numbers and distribution, in large part due to abandonment of marginal agricultural lands and active efforts to increase forest cover.

As a consequence of these increases in numbers and distribution we have also seen an increase in impacts on agriculture, forestry and natural habitats as well as increased involvement in collisions with road vehicles.

However declining – and ageing - hunter populations (at least in those systems where management is in some significant part dependent on activities of recreational/volunteer hunters) means that at a time when management need is on the increase, management capacity is decreasing. At the same time, increased urbanisation of human populations leads to disengagement with countryside issues and a change in public attitudes, including a marked reduction in tolerance of lethal control, exacerbating problems of management. So where do we go from here?

Other issues of concern include issues of conservation of endangered taxa; the likely implications of efforts to re-establish or reintroduce large carnivores and issues associated with (historic) introductions of invasive alien game species.

Wolf monitoring by hunters - Involving an affected interest group in the monitoring of a conflict species

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Keywords: wolf, monitoring, conflict species, *Canis lupus*, hunter

In an intensely used and densely populated cultivated landscape, efficient management is the basis of a low-conflict coexistence between wildlife and humans and requires reliable data. In Lower Saxony, the return of the conflictual wildlife species wolf (*Canis lupus lupus*) is scientifically documented by the Hunters' Association of Lower Saxony. Hunters' activities cover all Lower Saxony, they are taught and examined to detect wildlife signs, and as directly affected, they are interested in efficient monitoring. The wolf monitoring in Lower Saxony is primarily passive. The reporting of probable wolf presence is done by hunters, trained volunteers or the public. Active measures complement the monitoring and help to analyze local wolf activities. The standardized documentation allows international comparability and scientific validity. Already 22.314 records have been reported to the Lower Saxonian wolf monitoring since 2011. Out of these reports, 51.51% came from hunters, 22.09 % from non-hunters and 26.40 % from people who cannot be assigned to either group based on the available information. The results show that hunters make a significant contribution to wolf monitoring. The system in Lower Saxony is exemplary because, for the monitoring of conflicting wildlife species, the inclusion of affected interest groups plays an essential role in comprehensive monitoring.

Wolves back in Lower Saxony – The first ten years of the recolonization

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Keywords: wolf, monitoring, conflict species, *Canis lupus*, hunter

For more than 20 years, wolves (*Canis lupus lupus*) are recovering in Central Europe, especially Germany. For an endangered and conflictual wildlife species, efficient management strategies based on reliable monitoring data are indispensable. In the federal state of Lower Saxony, the first evidence for the return of wolves has been recorded in the year 2007. Territorial wolves are proven since 2011 when the Hunter's Association of Lower Saxony has taken over the official monitoring of this strictly protected species. Wolf monitoring in Lower Saxony is active (camera trapping, genetic sampling) and passive (reporting of hints by the public). Based on nationwide standardized documentation, 138 reported wolf hints had been recorded in the monitoring year 2011/2012. In the following nine years, the number of reported wolf hints has risen to 4,531 records per year. For the whole period of 10 years, a totally of 22,403 datasets have been registered. With the help of verifiability criteria, most records were rated as unconfirmed hints (54.1 %), so wolves could neither be confirmed nor excluded. 35.41 % of all the records have been rated as clear evidence, where hard facts clearly verified the presence of wolves. Camera trap footages were the most represented hint-type (33.88 %), followed by sightings (31.62 %), scats (15.64 %), livestock kills (7.26 %), wildlife kills (6.37 %) and others (5.22 %). Until April 2021, the number of wolf territories climbed to 39, with an average increase of 57.75 percent per year. Of 580 overlaying ten by 10 km raster cells in Lower Saxony, 357 cells contain at least one clear evidence of wolf presence. Wolves are one of the best-monitored wildlife species in Germany, resulting in the accumulation of highly detailed datasets on various population parameters. Compared to the monitoring of other wildlife species, the input of resources (e.g., personnel, genetic analyses) is outstanding. The results of habitat suitability studies indicate further increases of the population size and range in Lower Saxony, probably leading to further increasing efforts in monitoring the species if the data accuracy should be maintained. Looking forward to monitoring large wolf populations in Germany, adaptations of the standardized documentation and stratified sampling should be discussed to ensure a cost-efficient and valuable scientific monitoring of this species.

Rethinking sustainable use of wildlife in a post Covid19 world [Keynote speech]

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Sustainable use of biodiversity is one of three pillars of the Convention on Biological Diversity and a focus of the emerging Post 2020 Global Biodiversity Framework. However, various forms of wildlife use have been challenged, particularly in the wake of COVID-19, with calls to ban wildlife trade and consumption due to pandemic risk. However, legal, sustainable wildlife use could contribute to post-COVID recovery, so we need to know what is both sustainable and safe. But how is sustainability measured? And where do issues such as human health and animal welfare fit in? This talk looks at some of the existing frameworks that are used to assess wildlife use, the dimensions of sustainability that these cover, and the gaps that need to be addressed if

we want to support sustainable, legal, traceable forms of wildlife use, which provide clear benefits for biodiversity and livelihoods but which also mitigate the risks to human and animal health.

Progress of ENETWILD project: towards an integrated monitoring of wild mammals in Europe

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Through the project carried out by the ENETWILD consortium (www.enetwild.com), the European Food Safety Authority (EFSA) aims to improve European capacities to monitor wildlife populations. First, we developed standards for the collection and validation of wildlife data (<https://efsa.onlinelibrary.wiley.com/doi/10.2903/sp.efsa.2020.EN-1841>). The standards must follow the criteria of: i) being flexible and robust allowing to filter data by quality to feed predictive models, ii) being compatible with existing biodiversity/disease data collection systems to ensure inter-operability. ENETWILD has created and promoted a data repository which initially focused on wild boar abundance and distribution data and is now moving to other groups of species (other ungulates and carnivores). Existing data were collated through a data sharing agreement with data owners and harmonized with the help of a specific data model.

As a consequence, important progresses have been made in the field of spatial distribution modelling of wildlife species at European level (e.g.

<https://efsa.onlinelibrary.wiley.com/doi/10.2903/sp.efsa.2020.EN-1871>).

Guidelines for reliable abundance estimation of wild mammals

(https://enetwild.com/2020/11/23/wildlife_abundance_guide/) and detailed protocols on field methods (<https://enetwild.com/2021/03/20/ct-protocol-for-wild-boar/>) have been published.

A network of data providers (data and metadata on species distribution, abundance and density) has been established and supported, including training on study design, methods, field protocols and easy-to-use data analysis tools (e.g. from camera trap data) to estimate local density of populations. All together these actions are planting the seed of a pan-European network capable of providing reliable data on wildlife abundance on a long-term basis. This observatory aims to help overcome existing data gaps and workflow bottlenecks in the context of current European-wide frameworks for monitoring terrestrial mammal populations. We consider this as a milestone towards a trans-national evidence-based management of those wildlife species and wildlife-borne diseases having a potential impact on economy and human health.

Examples of individual wintering strategies of Eurasian Woodcocks (*Scolopax rusticola*) in Central Europe

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Recent technical development of satellite tracking allowed the study of Woodcocks' migration and wintering strategies, further expanding the knowledge gained by observation- and ringing-recapture data of more than one century. In our study, we analysed individual wintering strategies and the wintering behaviour of Eurasian Woodcock in the Central-European region in Hungary.

We used tracking data of 5 Eurasian Woodcocks captured and tagged between 20th October and 10th November 2020 in a forest-agriculture mosaic landscape in Hungary to study their movement characteristics. Pinpoint GPS Argos 240 transmitters (Lotek Wireless Inc.) attached with leg-loop harnesses were used for tagging adult birds (at least second winter). The transmitters were programmed to record one GPS location per day.

Four of the five individuals left the tagging site during the autumn and winter period. There was a major difference in the departure date among the birds, as the first individual left on 1st November 2020 and the last one on 16th January 2021. Despite the severe weather in mid-January, one individual remained at the tagging site until the end of March 2021 and started migrating to a remote breeding site. Interestingly, one individual left due to a cooldown in December, but two months later returned exactly to the tagging site and spent another month before the onset of spring migration. Migration of the tagged individuals showed 'long flight long stay' strategy when intensive; several hundred kilometres of migratory flight were changed to small scale local movements when arrived at the stopover site. Regardless of their wintering site, tagged Woodcock stayed within a restricted area and showed high repetitiveness to change the night feeding area to daytime shelter daily.

The migratory strategies of tagged Woodcocks showed high individual variance. The birds used the tagging site either for overwintering, short time or long-time autumn stopover. Some individuals even returned during the pre-nuptial migration to the tagging site, while others overtook Hungary to make the spring stopover further North-East. We conclude that Hungary may be an important stopover site for a significant proportion of the migrating Woodcock population. However, due to mild winters experienced in the last decades, many individuals may attempt to spend the winter in the Carpathian Basin. They only leave the region when low ambient temperature and related decreasing feeding opportunities probably narrow down their body reserves under a certain threshold.

Pre-nuptial migration phenology of Eurasian Woodcocks (*Scolopax rusticola*) wintering in Central Europe

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In the last decades, bird ringing revealed the main migratory patterns of Woodcock populations wintering in Western- and Southern Europe. The same populations were in focus when the recently revolutionized satellite tracking technologies allowed the study of individual migrations. In contribution to these efforts, we studied the pre-nuptial migration of Woodcocks captured and tagged with GPS-Argos transmitters in Central Europe in 2020.

We used tracking data of 6 Eurasian Woodcocks tagged between mid-February and mid-March 2020 in Hungary to study their migration characteristics. Pinpoint GPS Argos 240 transmitters (Lotek Wireless Inc.) attached with leg-loop harnesses were used for tagging. The transmitters were programmed to record one GPS location per day. Despite the small number of birds, both sexes and age classes were represented in our sample. We analyzed the distribution of distances between the localization of consecutive days to characterize the birds' behaviour.

The birds remained near the site of tagging for 2–4 weeks. After that, Woodcocks migrated from the tagging site in Hungary to Ukraine, European Russia and Central Siberia by an average of 2,700 km. The migration duration ranged between 1–52 days, and the overall migration speed was 380 km/day; the absolute maximum distance covered in a day was 870 km. The routes of the birds and the phenology of their migration also showed large individual differences. Some of them reached their European breeding grounds with a single significant displacement.

In contrast, the other ones migrated up to 5,000 kilometres east of the Ural Mountains and included several (maximum 5) stopovers along their routes. The average time spent at each stopover site was six days. Within the stopover sites, the daily displacements were not more than 3,300 m.

We conclude that the Carpathian Basin may be a more critical wintering area for Woodcocks than previously assumed, as tagged birds stayed significantly longer than any later stopover site. In accordance with the results of previous DNA analysis from the same region, identified breeding grounds of the tagged individuals represented a large part of the species distribution area.

East or west home is best: Homing behaviour of translocated female red deer

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Keywords: biologging, movement reconstruction, navigation, GPS telemetry

Homing behaviour has been shown across many taxonomic groups, including mammals but not fully described in controlled experiments of large free-living herbivores. Our study focuses on red deer response to homing ability, spatial navigation, and orientation in an unknown environment. We tracked 23 individuals of female red deer in two different populations using GPS telemetry for at least 2 years. We translocated all individuals (one by one) to new localities where the animals have never been before after the first year of tracking. The release point was based on the animal previous home range. Animals were translocated from 13 to 18 km away from home range centroids. All translocated animals were tagged with Daily Dairy (Wildbyte Technologies, UK) placed on the collars and set up for 10Hz sampling frequency of accelerometer and magnetometer. GPS telemetry was fixed every 30 minutes and support biologging data during dead-reckoning. Dead-reckoning analyses provided a detailed reconstruction of homing movements and animals' compass heading. Twenty-one individuals return to their home ranges. Results are showing different magnetic alignment directly after translocation, during homing and inside the natural home range. We presume that north-south alignment preferences during the stage after relocation are inducing 'head compass' calibration and triggering the process of navigation – homing.

Possible effects of feeding habits of the golden jackal (*Canis aureus moreoticus* Geoffroy, 1835) on the big game population in Northeast Hungary based on stomach analysis

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The expansion of golden jackals (*Canis aureus*) in many regions of Europe has raised public concerns, especially in hunting associations. In Hungary, the species extinct in the early 20th century and returned in the 1980s with a growing population in Pannonian ecoregions. However, they have recently emerged in new areas of the country, typically in North-East Hungary. The hunters did not welcome the appearance of newcomers in the region because of their assumptions for the negative impacts on the big game population. Furthermore, there was no official data on the feeding habits of the golden jackal in this area previously. Two main objectives of the research are: 1) Provide basic information on the diet and feeding behaviours of jackals in North East region of Hungary; 2) Figure out the diet of golden jackals, from that making implication on the possible direct negative impacts on the big game population. The method was used in the research is analyzing stomach contents of golden jackals collected with the help of the regional chief hunters. Overall, there were 35 shot individuals in the region between July 2017 and October 2018. According to mass weight proportion (M) and relative occurrence frequency (F), food items were calculated according to mass weight proportion (M). Results showed that within food-contained stomachs (n = 31), the mean weight of food content is 249.25 ± 49.35 g while the empty stomach (n=4) weight after dissection is 92.93 ± 4.23 g. The most important food was flesh/carrion in term of mass weight proportion (M = 24.9%, F = 11.4%), while the most present food item in term of occurrence frequency was other plant materials (M = 16.4%, F = 26.6%). Following the flesh/carrion by mass weight were fur/hair (M = 22.5%, F = 17.9%), small mammals (M = 16.9%, F = 15.0%) and other plant materials (M = 16.4%, F = 26.6%). In the 31 samples investigated, only 19 samples (61.3%) recorded the ungulate contents inside the stomach, which means that more than half of golden jackal samplings ingested ungulates as their food intake. According to analysis, the golden jackal is an opportunistic scavenger with an omnivorous diet containing both animal and plant components: The diet is more specialized for animal origin food sources in amount, typically deer, vole, and wild boar. Investigating several ungulates body parts also revealed evidence for the highest amount of fur/hair in the diet, which implied that jackals are scavengers feeding indirectly on food remains from other predator's hunts or human hunting. Sex, age and seasonal variation did not significantly affect the diet but somehow reflected the social behaviours and capacity of jackals, also food source availability. The increasing trend of the big game population throughout the years and golden jackal expansion also shows a low chance of direct

negative impacts caused by jackals to game population growth. However, a larger-scale study is needed to clarify the diet variation and preferences of gold jackals in this area.

Accuracy of age estimation (field judgement and dental abrasion) of local red deer (*Cervus elaphus*) and influence of infection status with the large American liver fluke (*Fascioloides magna*) on mandible growth

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Objective: To determine the age of wild animals, different approaches and methods are used in practice. Probably the most frequently used methods for age estimation are field judgement of game and estimation of dental abrasion. This study assessed the accuracy of these two methods and their deviation from the actual age in local red deer. In addition, we investigated a possible growth depression in jaw length of animals infected with the giant liver fluke (*Fascioloides magna*).

Methods: 142 red deer (*Cervus elaphus*) jaws were examined for their actual age using the Mitchell tooth grinding method on the first molar. With a scroll saw and a long neck drill grinder, the cement zones were processed and evaluated with a binocular. Where applicable, the age was defined by the tooth formula. The age determined in this way was considered "real" and compared with the age data of field judgment and the age estimation due to the dental abrasion. The individual 2 jaws (mandibles) lengths were measured and grouped according to the real age and infectious status.

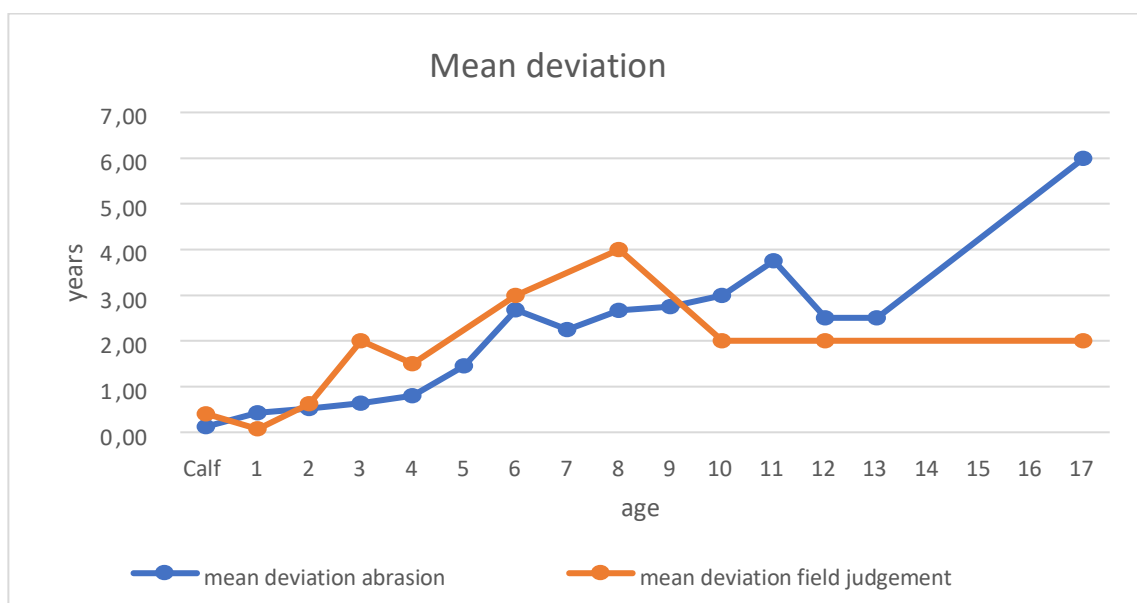


Figure 1: Mean deviation of age estimates

Results: In 139 of 142 individuals, the real age could be defined (97.88%). Forty-eight individuals were identified as calves, 15 as 1 y, 22 as 2 y, 11 as 3 y, 15 as 4 y, 11 as 5 y, 4 as 6 y, 2 as 7 y, 3 as 8 y, 2 as 9 y, 1 as 10 y, 2 as 11 y, 1 as 12 y, 1 as 13 y, and 1 as 17 y of age, respectively. Age estimation (field judgement or due to dental abrasion) underscored real age with a higher deviation of field judgement, especially in the mid-age population (2-10 y of age) (Figure 1). The mandibles showed growth depression with shorter lengths in young, strongly infected animals. However, in adult animals, this phenomenon was not observed.

Conclusion: The estimation of age-by-age characteristics shows a high inaccuracy. An age estimation based on tooth abrasion with better accuracy (< 1 year deviation in animals younger than 5 years of age) is certainly usable for some scientific questions. However, the accuracy deteriorates with increasing age. Reasons for this may be differences in the tooth material itself, in the ingested feed or habitat selection. Infection with the giant liver fluke (*Fascioloides magna*) leads to jaw growth depression as a sign of affecting the animals' condition. This is especially evident in young animals that are still growing. Older animals with jaws already fully grown before infection do not show shorter mandible lengths.

Population limiting mortality factors affecting wolves in Western Europe's cultivated landscapes: Denmark and northernmost Germany as examples

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Wolves (*Canis lupus*) are currently re-colonising Europe following legal protection. Still, traffic accidents and illegal persecution may limit further population expansion in landscapes highly impacted by humans by creating local population sinks.

We analysed mortality and disappearance rates of 35 wolves, 2007-2019, by genetic monitoring in the heavily cultivated and densely populated Jutland peninsula (Fig. 1). Jutland comprises a Danish part (29 778 km², 87 people km⁻²: 12% developed, 61% farmland, 23% forest and heathland) to the north and the German federal state Schleswig-Holstein with Hamburg (16 430 km², 272 people km⁻²: 10% developed, 68% farmland, 11% forest) to the south. It connects to the Central European mainland by a 60-km wide stretch of land between Hamburg and the Baltic Sea.

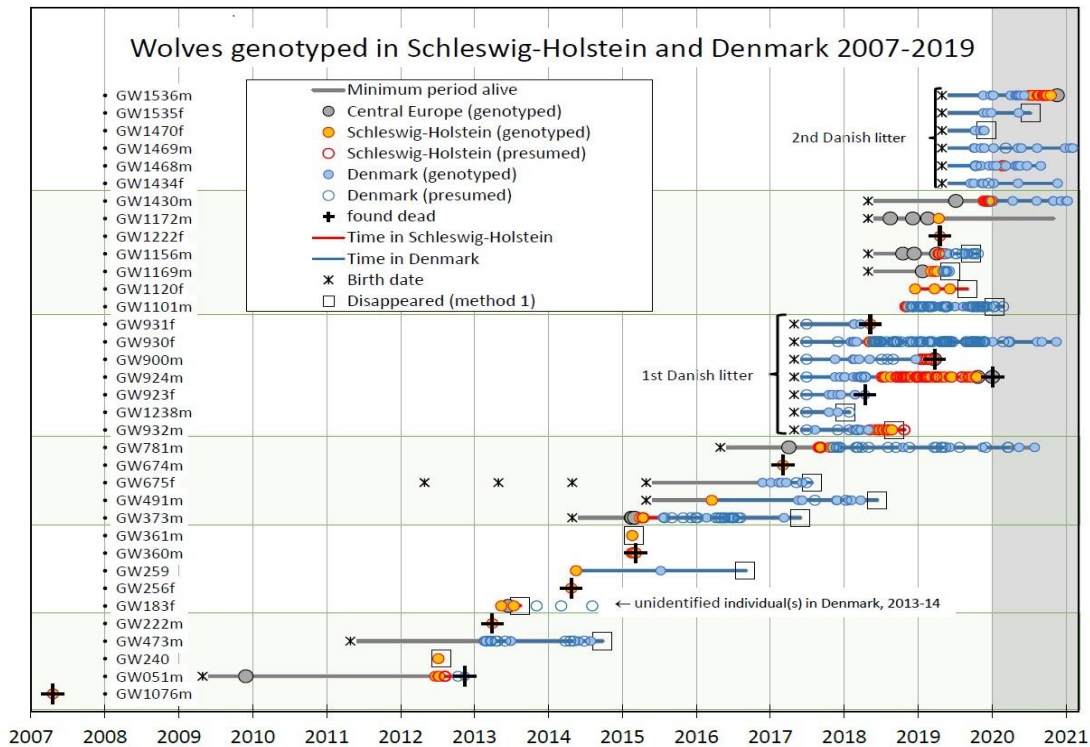


Figure 1. Observation timelines of the 35 genotyped wolves registered in Schleswig-Holstein and Denmark, 2007-2019. Data obtained after 1 January 2020 was not included in the mortality analyses and are marked with a grey-shaded background.

Thanks to the geography and frequent genetic sampling, especially in Schleswig-Holstein (mean sampling interval in 2019: 5 days), wolves in the region are registered with high temporal resolution. While immigrants from Central Europe on average stayed 38 days in Schleswig-Holstein before moving on, no wolves returned to Germany upon arriving in Denmark, where they established permanent territories. Wolves in Denmark successfully reproduced in 2017 and 2019.

In the German part, annual traffic kill rate estimates ranged from 0.37 (95% CI: 0.11-0.85) to 0.78 (0.51-0.96), whereas no traffic kills were registered in Denmark. Most traffic deaths occurred in a delimited ‘death zone’ around Hamburg. This emphasises the potential importance of local areas with heavy traffic as regional population drains.

In Denmark, the most apparent deaths were cryptic, corresponding to annual mortality (most conservative estimate) of 0.46 (0.29-0.67). With an 87% registration probability of wolves passing through Schleswig-Holstein, and no immigrants returning from Denmark, all or at least the vast majority of wolves that disappeared in Denmark must have died there.

The most conservative estimates of annual mortality rates in Schleswig-Holstein and Denmark exceeded the maximum sustainable harvest rates and total sustainable mortality rates for wolf populations. We, therefore, conclude the region is a wolf population sink, primarily driven by traffic in Schleswig-Holstein and illegal killing in Denmark. We hypothesise that frequent encounters between wolves and wolf-averse persecutors in cultivated landscapes may cause unsustainably high mortality rates despite the majority of hunters respecting protection laws. If we are right in this presumption, illegal persecution may be a significant factor, limiting further wolf expansion in West-Central Europe.

Spatial analysis of wild boar rooting can help reveal its impact on oak regeneration.

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Wild boar (*Sus scrofa*) is the most widely distributed ungulate in the World, and its populations have rapidly increased over the recent decades. This population explosion means a severe challenge to wildlife and forest managers. Wild boars can play a critical ecosystem engineer role, but their population increase led to an intolerable level of impacts on their environment in many places. They are often regarded as one of the central mitigation agents in oak and beech forest regeneration. However, our knowledge about their most peculiar behaviour, the rooting, is limited. Our study's longitudinal extension of the rooted patches was measured along 12 transects in a 28-ha oak forest stand, monthly between 2016 October and 2019 December. We also tracked the density of the acorns at 118 sampling points on the ground as an explanatory variable for the rooting intensity of the area. The study site was divided into 400 m² grid cells to investigate the rooting patterns. We used two different types of analysing approach: a) simply marking the cells with discrete variables, as rooted or undisturbed, or b) characterising the cells by the length of the rooting we found in them, as a continuous variable. Comparing the acorn densities among years, we stated that the oaks were masting in the first two years, but not in the last two. Unsurprisingly, we found that the forest area was used much more by wild boars when oaks were masting. The most intensely rooted sites (rooting hotspots) during the acorn fall period between September and November can predict the place of mostly rooted spots later until spring. We revealed that the hotspots showed partially similar spatial distribution between masting years, but these patterns were distinct when the oaks were not masting. However, there was no clear relationship between local acorn density and rooting intensity. These analysis approaches can lead the way to obtain a better, more subtle understanding of wild boar rooting dynamics and their actual impact on forest regeneration.

Compared accumulation of toxic elements in bone marrow and bone of red deer living in various ecosystems. A case study of farmed and wild-living deer

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Keywords: *Cervus elaphus*; toxic elements; bone; bone marrow; heavy metals; absorption

Purpose/objective: Toxic elements such as Be - beryllium, Al - aluminium, As - arsenic, Cd - cadmium, Sb - antimony, Ba - barium, Pb - lead, V- vanadium, Ni - nickel, Tl - thallium may be negatively impacted to bone cells even at low concentrations level. Therefore, the study aimed to determine the concentrations of toxic elements accumulated in the bone marrow and bones (*Cervus elaphus*).

Material/methods: The studies were carried out on two groups of young stags: farmed (n=6) and wild (n=9). Their body weight was measured, and bone and bone marrow samples were. The concentrations of toxic elements were analyzed using the inductively coupled plasma mass spectrometry technique.

Results: The mean Al content in the bone marrow and bones of the farmed animals was significantly higher than in the wild group ($p < 0.05$). The mean concentration of As, Ba and Pb in the bones of the wild red deer was significantly higher than in the bones of the farmed animals ($p < 0.05$). In contrast, the Cd concentration in the bones of the farmed red deer exceeded the value determined in the wild animals. A significant difference was found between the mean concentrations of Al, As, Ba, Pb, V and Ni in the bone marrow and bones of both red deer groups ($p < 0.05$). The concentration of Ni in the bone marrow and V in the bones of the wild red deer declined with the increasing body weight, while the concentrations of Sb and Ni in the bones in all animals were proportional to their body weight.

Conclusions: Toxic elements (Al, As, Ba, Pb, V and Ni) accumulated in deer bones may originate from bone marrow, given their higher concentration in hard tissues. However, this should be investigated more comprehensively. Although the study involved animals living in an uncontaminated area, the concentrations of some heavy metals were higher than values reported from industrial regions.

Compared accumulation of macro- and microelements in the bone marrow and bone of wild and farm red deer (*Cervus elaphus*)

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Keywords: availability of elements, diverse living conditions, wild and farmed animals, ICP-MS, bone and marrow composition

Purpose/objective: The study aimed to determine the concentrations of macro- (Ca- calcium, P- phosphorus, Mg- magnesium, K-potassium, Na- sodium) and microelements (Li - lithium, Cr - chromium, Mn - manganese, Co - cobalt, Cu - copper, Zn - zinc, Se - selenium, Mo - molybdenum, and Sn - tin) accumulated in the bone marrow and bones of deer (*Cervus elaphus*).

Material/methods: The studies were carried out on 15 young stags divided into farmed and wild animals. The concentrations of macro- and microelements were analysed using the inductively coupled plasma mass spectrometry technique.

Results: The mean content of K, Na, Zn and Se in the bone marrow of the farmed animals was significantly higher than that in the wild deer, whereas the mean content of Ca, P, Mg, K, Na, and Li in the bones was higher in the wild than farmed individuals ($p < 0.05$). In turn, the mean concentration of Cr, Mn, Cu, Se, and Mo in the bones of the analysed animals differed significantly ($p < 0.05$) and was higher in the farmed deer. The mean concentration of Se in the bone marrow of the wild deer decreased with the increasing body weight ($p < 0.05$). In turn, the mean content of Mn in the bone marrow and Mo in the bones of the animals was significantly positively correlated with their body weight ($p < 0.05$).

Conclusions: The higher level of macronutrients in the bones of wild deer may be related to the higher physiological importance of these minerals compared to their probably variable availability in food. Higher levels of most microelements were determined in the tissues of the farmed animals, indicating their significantly better nutritional status in the first year of life, which is related to a well-balanced diet of these deer.

An overview of ungulate impacts in the urban habitat of the strictly protected Caspian whipsnake (*Dolichophis caspius*) in Hungary

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Keywords: Ungulate, wild boar, deer, urban wildlife, reptile, shrub encroachment, Budapest

Ungulate activities can have significant top-down effects on the structure of plant communities resulting in indirect impacts on the habitat of other animal species. Our research looks at such impacts of ungulates in an urban habitat of strictly protected Caspian whipsnake (*Dolichophis caspius*). We surveyed an area of 3.2 ha in Vöröskővár in Budapest, where shrub encroachment is a threatening factor for the reptile habitat. To study the ungulate impacts on these succession processes, we conducted different investigations. We captured aerial images by Phantom 4.0 drone and converted the images into an ortho-mosaic using Dronedeploy, then digitized the shrubs from the ortho-mosaic and calculated the area covered by shrubs and shrub density in 20x20m grid cells. We also investigated the possible impacts of wild boar rooting on shrubs; for this purpose, we designated adjacent rows of 20x20m grid cells parallel to each other (n=81). We collected GPS data of rooted patches monthly and estimated by field observations the area covered by rooted surface and availability of woody vegetation in each cell. Parallely, we evaluated the relationship between deer pressure and plant food supply, using a unique wooden frame of 50x50x30cm and counting the number of available and browsed woody shoots along a 1km discontinuous transect. The results show that wild boar activities such as rooting are considerably high. On average, 59% of cells were rooted. However, browsing pressure may have much less impact on the shrub encroachment process in the area than rooting. Jacobs' index showed that deer avoid most species, and more than half of browsing was on the dominant species, namely on *Crataegous monogyna*. The availability of different patches in the area makes a suitable habitat for *D. caspius*. Meaning 51% of cells were covered with less than 45% shrubs (0 – 40%), implying the availability of some open patches among shrubs. Moderate wild boar rooting can play an essential role in maintaining some open spaces in the habitat of the Caspian whipsnake. Therefore, management needs to monitor and, if necessary, control ungulate densities and their impact on the vegetation even in such special urban habitats to avoid the adverse and enhance the beneficial changes of the vegetation for rare reptile species.

Trends in waterfowl bag reported by hunters, 2005-2020, Latvia

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Purpose/Objective: National legislation foresees that hunters report hunted waterfowl by species at the end of hunting season to the State Forest Service. SFS publishes national totals since 2013. Registration of sex and age is not mandatory. To obtain more detailed demographic information, bag checking at the 5 largest bird lakes has been organized (Vīksne et al. 2006, Janaus, Keiřs 2018). This report deals with obtaining demographic data of hunted waterfowl from hunter reports from different countries.

Material/methods: Questionnaires asking for species, age and sex of the bagged birds were distributed in 2005-2020. A web page to aid species identification was provided (www.nomeditie.org), and hunters were also asked to send photos of their hunted birds in 2019-2020. Generalized linear models were used to evaluate changes in species occurrence, percentage of young birds and index R (young birds/adult female). On average, 4% of the total national bag were reported in such a more precise way.

Results: During 2005-2020, the hunters' bag reported to us has decreased for Mallard and Coot and has increased for Gadwall.

The percentage of juveniles in the hunters' bag shows a statistically significant decrease in Mallard, Teal, Gadwall, Coot.

Index R (young birds/adult females) showed a statistically significant decrease for Teal.

Conclusion: An increase in Gadwall can be explained by the rise in the local breeding population and establishing moulting sites previously unknown.

Only for Mallard, the lower proportion of juveniles showed a significant but not strong correlation with the opening date on the 2nd Saturday of August.

As the hunting season lasts till the end of November and local birds are hunted, more investigation about bird origin is needed to explain the decrease in juvenile proportion and R.

Prevalence of gastrointestinal parasites in a lowland black grouse population in Central Europe*

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Purpose/Objective: Since the nineties, the black grouse (*Tetrao tetrix*) population in Germany has been characterised by a substantial decline. In the Northern German lowland, the autochthonous metapopulation repeatedly decreased over the last decades. The reduction of genetic variability resulted from isolation and fragmentation of this metapopulation may reduce individual fitness and hinder the immune system of black grouse, which, in turn, could lead to an increased susceptibility to infections such as gastrointestinal parasitoses.

Material/methods: Therefore, between 2012 and 2014, the occurrence and seasonal variation of gastrointestinal parasites were assessed by coproscopical investigations of black grouse faeces collected in the nature conservation area of the “Lüneburg Heath” Lower Saxony, Germany.

Results: 1,187 faecal samples were analysed (365 caecal and 822 rectal faeces samples). 86% of the caecal and 95% of the rectal faeces samples were parasite negative. Of the parasite positive samples, oocysts of *Coccidia* spp. showed the highest prevalences of 12.1% in caecal and 1.1% in rectal samples, respectively. Helminths of the species/genera *Trichostrongylus tenuis*, *Ascaridia* spp., *Heterakis* spp., *Capillaria* spp. and *Syngamus trachea* were also observed, but at remarkably lower prevalences. High and moderate excretion intensities were observed only for coccidian oocysts. Coccidian infections revealed a seasonal pattern, mainly occurring during autumn and winter, whereas nematode eggs occurred more frequently in spring and summer.

Conclusion: In contrast to previous studies, our studied black grouse population showed generally low prevalences of a relatively narrow spectrum of parasites. We did not observe any negative health impact of parasite infections on this metapopulation, responsible for the reported decline. However, high/moderate oocyst excretion was observed in the parasite positive samples. This likely suggested low pathogenicity of the infecting coccidia species or subsided infections due to developing immunity. Thus, the causes of this decline are ascribed to other factors that still need to be analysed.

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Seeking explanations for rooks shifting rookeries to urban areas and depredating sensitive crops in Denmark

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Purpose/Objective: The annual numbers of breeding rook (*Corvus frugilegus*) pairs in Denmark have been stable at c. 85,000 for over 25 years. Despite this, rooks are causing increasing economic conflicts and nuisance to humans. In particular, people living close to breeding colonies perceive rooks as a nuisance. As more birds move into urban areas, complaints have increased dramatically, resulting in derogation shooting of fledglings being common practice. Farmers increasingly experience severe losses to rooks, primarily due to damage to newly sown organic maize, baled silage, strawberries, and cereal crops. We present preliminary results from telemetry and transect sampling to determine seasonal changes in habitat use to understand how sensitive crops become disproportionately attractive to rooks in relation to the availability of alternative food sources at critical times of the year. In this way, we also help explain the increasing establishment and growth of rookeries in semi-urban and urban areas, despite stable population size.

Material/methods: We analysed historical and recent data to describe changes in distribution and size of colonies in rural and urban areas monitored since the late 1960s. We tracked individual birds using GPS telemetry in summer (fitted with 10 g Milsar RadioTag-14) and mapped the habitat use of flocks from late winter through to the end of the breeding period.

Results: From long term monitoring of breeding distributions and abundance, we demonstrated how a growth in colony numbers accompanied decreasing colony size. This was potentially a result of the derogation shooting of fledglings, leading to the dispersal of adults to establish new colonies, which may, in turn, cause further conflicts.

Telemetry showed how this central foraging farmland bird uses and strongly selects for short grass swards in a semi-rural landscape during summer, which may partly explain why rooks are increasingly feeding in urban areas, where such habitats, provided by lawns, recreational areas, etc., are widespread and available throughout the year, in contrast to out in the modern agricultural landscape.

Mapped rook farmland distributions in late winter through to summer confirmed trends observed among tracked individuals. Rooks increasingly selected short grass swards from late winter into the pre-breeding and nesting period, especially towards summer. When crops grow tall, ploughing, and sowing cease, and the availability of short-grazed grassland becomes highly restricted.

Conclusions: We discuss the implications of the current management regime, the historical development of the population, the distribution of rooks between urban and rural areas, and the potential impact on the extent and nature of the conflicts. We conclude that current and

historical management practices may have had undesirable side effects and may have exacerbated the conflict.

Spread of the invasive alien species raccoon, raccoon dog and coypu in Lower Saxony 2003-2020

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Purpose/Objective: According to the EU regulation 1143/2014, 22 invasive alien vertebrate species (IAS) are of Union concern to date, among them raccoon (*Procyon lotor*), raccoon dog (*Nyctereutes procyonoides*) and coypu (*Myocastor coypus*). Within this legal framework, EU member states are obliged to monitor and, if necessary, prevent the spread of IAS at an early stage. The IAS as mentioned above have been released in Germany at the beginning of the 20th century or, in the case of the raccoon dog, immigrated from the Eastern part of Europe and are considered established nowadays. Therefore, the Federal States of Germany have agreed upon a management strategy that can be shaped by each state individually. This agreement and plans are shared online by the German Federal Agency for Nature Conservation. The action plans mainly to address the population control of IAS, taking into account proportionality, the environmental impact, and associated costs. They are subject to hunting as well as animal welfare regulations as game species. In the case of single occurrences, the prevention of further spread can be necessary, considering the costs and risks of the actions. Here, we report the spread and hunting of the raccoon, raccoon dog and coypu in Lower Saxony (Germany), which has been continuously documented since 2005 as part of the wildlife survey and may serve as the basis for future IAS management plans.

Material/methods: Lower Saxony is divided into approximately 9,000 hunting districts. The average hunting district is 500 ha (minimum: 75 ha, maximum: 7,300 ha). In the wildlife survey of Lower Saxony (Wildtiererfassung Niedersachsen (WTE)), holders of hunting districts have provided estimates of wildlife such as occurrences, numbers of species and hunting bags, and hunting activity since 1991. Since 2005, IAS have been recorded in this wildlife survey as well. **Results:** Participation of hunting district holders was high throughout the years (1991-2020), with 80-90% of hunting districts participating, which covers over 90% of the huntable area in Lower Saxony (43,000 km²).

In the early 2000s, raccoon, raccoon dog and coypu were present in 6-15% of hunting grounds. In 2020, these three species occurred in 59%, 45%, and 52% of the hunting districts. These numbers are likely translatable to the land area of Lower Saxony as well. The hunting bag has increased exponentially in recent years. In Lower Saxony, 21,150 raccoons, 4,385 raccoon dogs

and 43,931 coypus were hunted in 2020 alone. Twenty years ago, the hunting bag was between 49 and 524 individuals.

Conclusion: Hunting plays an essential role in the IAS management of raccoons, raccoon dogs and coypu. However, this was, and will not be, sufficient to eliminate these species in Lower Saxony, nor can their widespread into the north German lowlands be prevented in the future, except the North Sea islands. The current IAS management strategy can only reduce population densities so that the damage can be tolerated and spread to previously unpopulated regions or neighbouring countries prevented.

Birth date estimation and early mortality in Bavarian roe deer fawns (*Capreolus capreolus*)

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(1) During spring and early summer, vegetation is at its peak regarding forage productivity for species such as roe deer. Wild ungulates strive to optimize their energy expenditure. As income breeders, roe deer are known to time the birth of their fawns close to the peak in plant production, which is considered one of the main drivers for the time of birth as the doe can receive high-quality feed to balance the energy expenditure of lactation. Roe deer fawns developed behavioural adaptations such as camouflage as well as laying rigid to impede detection. As a hider species, roe deer fawns are usually placed in vegetation by their mother. This strategy – moulded over thousands of years of evolution- now proves to be a fatal one in modern agricultural landscapes, leading to thousands of individuals being injured or killed by mowing. (2) Determining the date of birth in roe deer fawns can visualize differences in various habitats and, therefore, the danger of mowing mortality. Apart from the age of a fawn, the environment, litter size, maternal care and other factors are crucial for growth rate, constitution and condition during the first months of its life. Based on datasets collected in four Bavarian study areas, the time of birth in roe deer fawns will be calculated by combining already established methods and adding new estimates. In a joint research project that assesses mowing mortality in wildlife across Bavaria, roe deer fawns were captured and examined during spring and early summer of 2020 and 2021. Eight parameters of age determination were selected to estimate the date a fawn was born. To detect fawns, several models of thermal drones (UAV) were used. We collected the following parameters to estimate the time of birth: 1) weight 2) crown-rump-length 3) hind foot-length 4) hide-colour 5) umbilical cord 6) calls 7) behaviour 8) hoof-cartilage. Additionally, radio telemetry was used on selected fawns to observe locations and possible mortality events. If a mortality event occurred, the last known location of the fawn was visited to find out the cause of death. (3) A total of 140 data sets was obtained during 2020 and 312 sets in 2021. Sixty fawns were equipped with GPS collars in four study areas during 2021, of which 17 died due to predation (9), weather conditions (4), mowing (2) and unknown causes (2). This accounts for a mortality rate of 28%. (4) These findings can result in novel

information regarding the ecology of roe deer and assist in increasing knowledge regarding susceptibility to mowing and predation. In conclusion, management directives may derive from this research which may aid to decrease mowing mortality.

Qualitative assessment of social perception of European rabbit subspecies in the Iberian Peninsula: management implications

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Keywords: *Oryctolagus cuniculus*, agricultural pest, hunting species, human-wildlife conflicts, qualitative research, in-depth interviews

During the last decades, the European rabbit (*Oryctolagus cuniculus*) has suffered a significant decline in the Iberian Peninsula. In this place, the species is native and critical for biodiversity conservation and hunting, to the point to be declared as endangered by the International Union for Conservation of Nature. However, paradoxically, some Iberian populations, particularly in agricultural areas, have experienced remarkable growth in recent years, causing significant crop damage and generating social tensions.

In this context, it has been suggested that rabbit trends would differ in the distribution areas of its two subspecies, with the main decreases occurring in the distribution range of *O. cuniculus algirus* (Oca; i.e., in the southwest of the peninsula) and more stable or even positive trends in the northeast of the Iberian Peninsula where *O. cuniculus cuniculus* (Occ) is naturally distributed. This difference, together with other reported between the two subspecies at a reproductive, genetic, or morphological level, which are the result of approximately two million years of natural isolation, suggest that Oca and Occ may need an independent management strategy.

In this study, we tried to assess if the existence of both rabbit subspecies was noticed by representatives of the different social sectors involved in rabbit management in Iberia and, if so, how they valued the possibility of establishing independent management models for each subspecies. For that aim, we used a qualitative approach based on more than thirty in-depth interviews with hunters, farmers, conservationists, and members of different official agencies. Our results indicate that, although all the interviewees were aware of the existence of the two subspecies, most of them did not see how the subspecies could be an element at practice to consider when planning rabbit management. The interviewees who were most sensitive to rabbit subspecies and their possible differential management were primarily located in areas where Oca occurs. Interestingly, all the interviewees recognize an apparent lack of information about subspecies regardless of their position. In this sense, our study highlights the need for more research to help clarify the role of subspecies in rabbit management and conservation and the need for better knowledge transfer at the interface between science and society.

Emerging of *Lagovirus europaeus/GI.2/RHDV2/b* in the Iberian hare (*Lepus granatensis*) in the Iberian Peninsula: what consequences can we expect for wild populations?

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Purpose/Objective: In this study, we report for the first time the infection of a wild Iberian hare with *Lagovirus europaeus/GI.2/RHDV2/b*, potential shedding, associated histopathological alterations and potential implications to its wild populations.

Material/methods: On November 20th, 2020, a female adult Iberian hare was found dead lying on the ground in a hunting state in the province of Tarragona (Northeast of Spain). A systematic necropsy was performed, and all tissue sections from the Iberian hare were evaluated through immunohistochemistry (IHC) to detect the presence and localization of lagovirus antigen using a monoclonal antibody against the protein VP60 of rabbit haemorrhagic disease (RHD) virus. Additionally, samples of liver, spleen, duodenum, and faeces were analysed for molecular characterization. A diagnostic PCR was performed, which targets GI.1 and GI.2 lagoviruses.

Results: Main findings on the necropsy revealed a slightly enlarged pale friable liver with an enhanced reticular pattern and a few focal haemorrhages, mild splenomegaly, petechial haemorrhages in the thymus, and markedly congested/haemorrhagic cervical lymph nodes and tracheal mucosa. The microscopic pathology analysis of the hare confirmed severe hepatocellular loss and necrotic/apoptotic dissociated hepatocytes in haemorrhagic periportal to midzonal areas (Figure 1). These lesions were similar to those described in other hare species infected with GI.2. The results of the IHC in the tissues from the hare revealed that the distribution of the antigen was similar to that described in both natural and experimental

infection of RHD. The sequence of the lagovirus infecting the Iberian hare was 7360 nucleotides long and presented several in-frame deletions, similarly to GI.4 strains and GI.4P-GI.2 recombinant strains.

Conclusion: In the last few years, the Iberian hare populations had drastically decreased by the impact of myxomatosis. Therefore, the burden of a newly emerging disease such as RHD, with its effect on other wild leporids populations, could place the species in a worrying situation regarding its conservation. In this sense, it is worth studying the role that species-specific factors may play in the epidemiology of GI.2 on the Iberian hare, such as viral load, the clinical course of the disease, differences in susceptibility of the species to the infection, or the specific recombinant virus found. These non-exclusive reasons may explain why, despite the wider geographical distribution of the Iberian hare compared to the European brown hare in the Iberian Peninsula and the active search for the virus in this species, no more cases have been detected far and warrants future investigations.

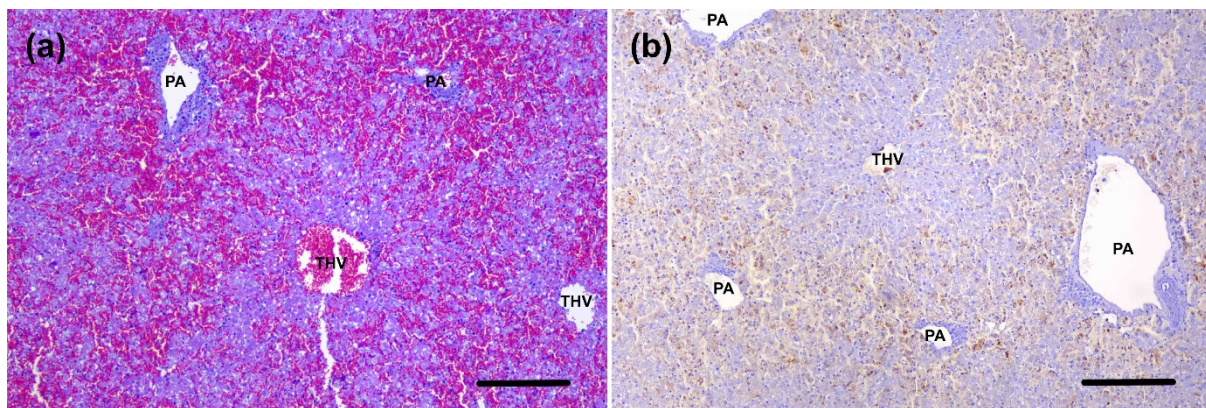


Figure 1. Microscopic lesions and viral antigen detection in the liver of a GI.2 infected Iberian hare (*Lepus granatensis*). (a) Acute to subacute haemorrhagic periportal to midzonal hepatocellular necrosis and apoptosis (PA, portal area; THV, terminal hepatic venule) and mild inflammatory portal infiltrates (H&E stain, bar=200 µm). (b) Immunohistochemical visualization of viral capsid antigen (brown) follows the same periportal to midzonal distribution (bar=200µm).

Wolf flight responses during experimental human approaches: a pilot study

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Conflicts arise with the recolonization of wolves in human-dominated landscapes, as some people experience fear based on the perception that wolves are dangerous and unpredictable. For some people, a concern for their own and their family's safety may result in diminished

quality of life. This challenge related to fear of wolves calls for collaborative tools for evaluating wolf responses to humans. Experiments in which humans approach GPS-collared wolves can increase our understanding of how wolves respond to humans and thus facilitate human-wolf coexistence.

We developed a standardized field protocol for experimentally approaching GPS-collared wolves to assess their responses to encounters with humans while controlling for factors such as habitat parameters and the number of approaching humans. Additionally, we developed a tutorial for using changepoint analyses to identify wolf flight initiation and resettling positions as a basis for extracting some flight parameters. We conducted a pilot study of the responses to experimental human approaches of seven GPS-collared wolves in Scandinavia based on these protocols.

We found that wolves predominantly showed a flight response (N = 17) and, in a few cases, a hide response (N = 3), but no wolves were seen or heard during trials. When wolves were downwind of the observer, the flight initiation distance was significantly larger, consistent with the expectation that conditions facilitating early detection result in an earlier flight. Our data did not support our expectation that early detection would result in less intense flights. We found no correlation between the flight initiation distances and the flight's speed, distance, or straightness. Wolves in concealed habitats had a short flight initiation distance or did not flee at all, suggesting that perceived risk might have been affected by the horizontal cover. Contrary to our expectation, resettling positions were not more concealed than the wolves' initial site.

Although our small number of study animals does not allow for generalizations of wolf behaviour towards approaching humans, this pilot study illustrates how human approach trials with high-resolution GPS data can be used to describe wolf responses at a local scale. Furthermore, standardized protocols can facilitate comparisons of wolf responses to direct interactions with humans, within and between populations. Results might be used to relate behavioural responses of individual wolves to a baseline distribution of wolf response patterns. We believe that showing how wolves in general and in specific cases respond to human encounters may de-mystify the behaviour of wild wolves towards humans in their own habitat.

Assessing the impact of natural and anthropogenic disturbances on temporal patterns of activity and feeding behaviour of red deer in a fenced Mediterranean ecosystem

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Wildlife species present multiple strategies to mitigate the impact of natural and anthropogenic disturbances in humanized landscapes. Behavioural adaptations are likely one of their fastest responses to such disorders, allowing to increase their survival success when some type of external, unexpected factors emerge in their environment. In this context, we studied the impact

of a red deer (*Cervus elaphus*) driven hunt, which took place in late December 2020, and an extreme climatic event like the snowstorm Filomena in early January 2021 on the circadian activity patterns and feeding behaviour of red deer. Our ultimate goal was to generate knowledge that may inform us about wildlife and environmental vulnerabilities in the current global change scenario, where anthropogenic ecological impacts and climate events are forecasted to be increasingly frequent.

To do so, we conducted a camera-trapping survey from November 2020 to February 2021, totalling 1740 camera-trap days. Our sampling design consisted of 29 camera traps systematically deployed in a 4695 ha fenced game estate in Toledo (Spain) with a minimum distance of 1 km among the nearest cameras. We obtained 1740 cumulative hours monitoring, which provided 126,892 photos of 20 different vertebrate species; we identified 5929 red deer individual's records using this information. We analyzed red deer daily activity patterns and temporal variations in feeding behaviour using the densityPlot function (library overlap, R 3.6.3. software).

According to our results, red deer present a fast capacity to recover their usual activity pattern and feeding behaviour after the occurrence of both unusual and intense natural and anthropogenic disturbances. Remarkably, our results showed two maximum of red deer activity and feeding behaviour before perturbations: sunrise and dusk. During the big game hunt, a significant reduction of feeding behaviour was detected at sunrise and during the morning, followed by an increase in activity and feeding behaviour during the evening (when the big game hunt had finished). The successive days deer recovered their normal activity pattern and feeding behaviour after, which was already plausible one and a half-day after the hunting. The snowstorm event had similar consequences, with animals adopting a more diurnal activity pattern on the first day of snow. After that, deer recovered their normal activity pattern and feeding behaviour in only one day. Our results suggest that time patterns of red deer activity and behaviour at the fenced game estate do not stretch on much, stressing the strong resilience of this species to short-term solid perturbations. Nevertheless, further analyses on the consequences of spatial patterns inside the fenced area would be useful to fully understand their activity and behaviour.

Rutting vocal displays in a game species, Mongolian gazelle *Procapra gutturosa*

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Purpose/Objective: The Mongolian gazelle is a traditional ungulate game species of Mongolia. During the rut in December, males held harems and defend them against other males with aggressive displays attended by remarkable long series of rutting barks. Data regarding the acoustic structure of the barks are scarce, whereas information about other male and female call

types produced during the rut is lacking. The purpose of this study was to describe vocalisations produced by male and female Mongolian gazelles during the rut.

Material/methods: Calls were recorded from 10 to 25 December 2017 in Transbaikalia, Russia, using four automated SongMeter SM2+ recorders (900 hours in total). The devices were mounted at 0.5 m above the earth in places of concentration of the Mongolian gazelle harem groups, at a minimal distance between devices of 1 km. We also used a manual recorder Marantz PMD 660 with Sennheiser K6-ME66 microphone to determine the situation during calls. During the manual recordings (8 hours in total), the distance to animals was 150-500 m. Male callers were identified by visible vapour from the mouth or nose; female callers were identified by stomach and nostrils movements during the calling. Acoustic analyses were made using Avisoft SASLab Pro software.

Results: Male and female calls were classified into types based on spectrograms. Males call types included the nasal and oral barks, the closed-mouth snorts and the open-mouth running calls. Female calls included the oral and nasal “cat” calls and the closed-mouth snort. Male nasal and oral barks were produced in series up to a few dozen calls, each duration up to 100 ms. In the oral barks, visible frequency bands ranged between 500 and 750 Hz; in the nasal barks, the maximum energy was higher than 800 Hz. Male nasal snorts were noisy calls without harmonic bands of 200-250 ms, produced at a strong expiration when an animal spotted people or a car. The low-frequency (200-300 Hz) tonal-noisy open-mouth running call (up to 500 ms) was produced during an intense inspiration, commonly within series of barks emitted during fast female chasing.

Female cat calls (duration from 80 to 500 ms; fundamental frequency 400-500 Hz, sometimes up to 1000-1500 Hz) occurred singly or in irregular series. The cat calls were commonly low-intense but occasionally as loud as male barks. Females produce cat calls during contacts with other females within a harem or when running from a chasing male. Female snorts were similar to male snorts but were often made in irregular series and were never interspersed with barks.

Conclusion: This is the first investigation of calls produced by male and female Mongolian gazelles during the rut. In contrast to males, the female calls were surprisingly high frequency for such large animals and acoustically indistinguishable from the calls of neonate Mongolian gazelles described in a previous study.

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Effect of human presence on red deer behaviour in game farming: new stag vocalisations identified from automated recordings

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/Objective: Human presence modifies the behaviour of animals on game farms. The impaired behavioural repertoire is undesirable for game animals, so game managers try to retain wild-type behaviour in trophy red deer bred on the farms. The purpose of this study was to highlight the apparently lacking forms of vocal behaviour (contact calling) in untamed European red deer

stags. Previously, this kind of behaviour was only known for wapiti stags and European red deer hinds and calves.

Material/Methods: Automated audio recording with SongMeter 2+ device was used to record the calls of farmed untamed Iberian red deer stags (*Cervus elaphus hispanicus*). The device was mounted above the feeder and recorded all calls in 20 m around the feeder permanently for 20 hours per 24-hour cycle between 22 and 26 January 2018 from the four stags (of 7.5, 5.5, 4.5 and 3.5 years old) kept together in the paddock of 0.3 hectares separately from the hinds. The total length of recording was 90 hours. Acoustic analyses were made using Avisoft SASLab Pro software.

Results: By visual inspection of spectrograms, the recorded stag calls were classified into three types: roars, contact calls and bellows. For European red deer stags, roars were previously only described in the rutting periods. In contrast, stag contact calls were found for the first time in the European red deer stags, and the bellows have never been previously found in either stags or hinds of either red deer or wapiti. ANOVA showed that factor call type affected all acoustic variables. The roar was the longest among the three call types, with the highest maximum fundamental and peak frequencies. The contact call was the shortest and had maximum fundamental frequency intermediate between the roars and bellows, with peak frequency lower than in the roar but not differing from the bellow. The bellow was the lowest in maximum fundamental frequency and intermediate in duration between the roar and contact call.

Farm Iberian red deer stags in the non-rutting period produced the roars primarily at daytime (1.38 calls/h vs 0.14 calls/h at nighttime), whereas the contact calls and bellows were mainly made at night (contact calls: 10.0 vs 1.1 calls/h; bellows: 0.46 vs 0.03 calls/h respectively). Thus, some call red deer stags produce types only in the absence of people. The contact calls and bellows were emitted by the stags nearly exclusively at nights, so the keepers and managers even did not suspect that the stags on their farm produced such calls.

Conclusion: The apparent behavioural deficits in animals bred on game farms can be side-effects of human presence. These behavioural activities can be revealed with automated devices in the absence of people.

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Using digital photographs as an alternative method for collecting goose wing data

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There is no national bag recording scheme in the UK, so it is crucial to gather data and monitor our harvestable species through other methods. Wing surveys can provide invaluable information on the age and sex ratios of waterbird harvests which can, in turn, be used to provide trends in productivity. The UK's wings survey has previously obtained low levels of goose wings, likely due to issues with storage space. This pilot survey investigated the use of digital photographs of goose wings from hunters as an alternative method of collecting age ratio data. A list of 17 participants was compiled, including proactive members of BASC and BASC staff who are known to shoot geese. Epicollect5 was used to create a data collection form on which

hunters were asked to complete a number of compulsory fields, including the date the geese were shot and location (country & county) and two photo fields were made available, one for a wing photo and another for a head photo. Hunters were able to use either the app or the online version to submit data. A 'How to' guide was created to aid participants in downloading the app and completing the form; examples of good photographs were included.

A total of 97 goose wings were submitted through Epicollect compared to 91 submitted to the wing survey in 2019/20. The participants did not upload a total of 5 photographs, and four wings within the photographs were indeterminate due to feather conditions. If this method were made available to all members, it would likely boost the goose wing contribution to the wing survey substantially. However, there are some drawbacks of using Epicollect to assess and collect the data from the photographs.

Multifunctionality and biodiversity in a silvopastoral system

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Keywords: multifunctionality, agroforestry, biodiversity, ecosystem services, ecosystem functions, ecosystem management, wildlife management

Wooded pastures of the Swiss Jura mountains is a specific type of agroforestry system which may be defined as an assemblage of cattle grazed pastures and scattered trees. They have a high biodiversity value because of their richness in vegetation types influenced by irregular tree cover, resulting in a mosaic of habitats. Multifunctionality (MF) has often been shown to increase biodiversity. However, few studies have assessed this relationship at the landscape scale of human-shaped ecosystems, including different species. Based on previous literature, we propose an applied framework to evaluate the MF of a silvopastoral ecosystem linked to animal diversity that would support wildlife and habitat management planning.

We considered ecosystem MF at two levels. Ecosystem functions (EF) represent biotic processes supporting the overall ecosystem, and ecosystem services (ES) are defined and valued by humans. For each level, we selected a set of indicators to calculate indices of MF along a gradient of environmental heterogeneity. We considered both local and landscape scales. As ES are relevant to be measured at the local scale and EF are meaningful at the landscape scale. EF driven by animal's activity was found in literature focusing mainly on insects, birds and small to medium mammals' species. Specific indicators were identified to measure EF rates on the field. Transdisciplinary methods were used to identify relevant ES. Semi-direct interviews with different groups of stakeholders allowed us to target particular ES and their relative importance. Indicators directly linked to ES were then developed to measure ES rates on the field. To compare values of MF in different habitats, the pattern of spatial tree distribution was defined as a measure of habitat heterogeneity at the landscape and local scale. At the landscape scale, remote sensing data were used to categorize landscape portions according to patterns of trees distribution at the patch level. We used an existing Jura wooded pasture's typology at the local scale applied at the pastoral management unit to build vegetation categories according to the tree cover.

Through literature review, we identified animal provided regulating and supporting EF relevant to the Jura wooded pastures. Semi-direct interviews target supporting ES for agriculture and forestry and cultural ES for tourism delivered by wildlife. Ongoing fieldwork uses indicators derived from this study framework to compute values of MF at the different scales through the gradient of habitat heterogeneity. Meaningful selection of EF and ES according to the precise study context, using a transdisciplinary methodology revealed to target relevant indicators with concrete potential management application efficiently. Results of field indicators' surveys and quantifications of MF will enhance understanding of which species and habitat types better promote MF.

First results of a survey for hunters about wildlife rescue measures for roe deer fawns before mowing

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Purpose/Objective: The fawning season of roe deer fawns coincides with the first cuts of fodder crops, whereby fawns can get injured or killed. Less information is available about applied measures for fawn rescue in Germany. A survey was created to get information from hunters about the use of wildlife rescue measures before and during mowing in Germany to save roe deer fawns from mowing death.

Material/methods: A standardised, Computer Assisted Web Interview (CAWI) was designed with LimeSurvey to create an online survey for hunters nationwide. The survey has started on 18th May and will end on 30th September 2021. The questions are split into six topics: participant and hunting ground data, roe deer stocking density, communication and collaboration with farmers, fawn rescue measures, future developments and annotations.

Filter questions were set, and a pre-test was conducted with several hunters from all over Germany to check the practicability of the survey. None of the questions was set as mandatory. Therefore, the number of hunters answering the individual questions can vary. The obtained data until 21st June were evaluated with LimeSurvey, MS Excel and R.

First Results: 232 Hunters applied fawn rescue measures themselves. Their hunting ground was between 30 and 4500 ha (553±413ha; mean±SD, n = 219), and most of them were between 50 and 70 years old (n = 228).

with a dog, and search by person/ a human chain). Also, “more professional” tools like shoeing devices and high technologised measures like drones with a thermal camera, both primarily purchased in the last five years, were applied. With these measures, they were also most satisfied. On the contrary, the less used step was the portable wildlife rescuer. All in all, they were predominantly satisfied with most of their applied measures to rescue roe deer fawns from mowing death, but there seems to be a difference in satisfaction between used measures for fawn rescue ($P < 0.001$; chi-squared-test).

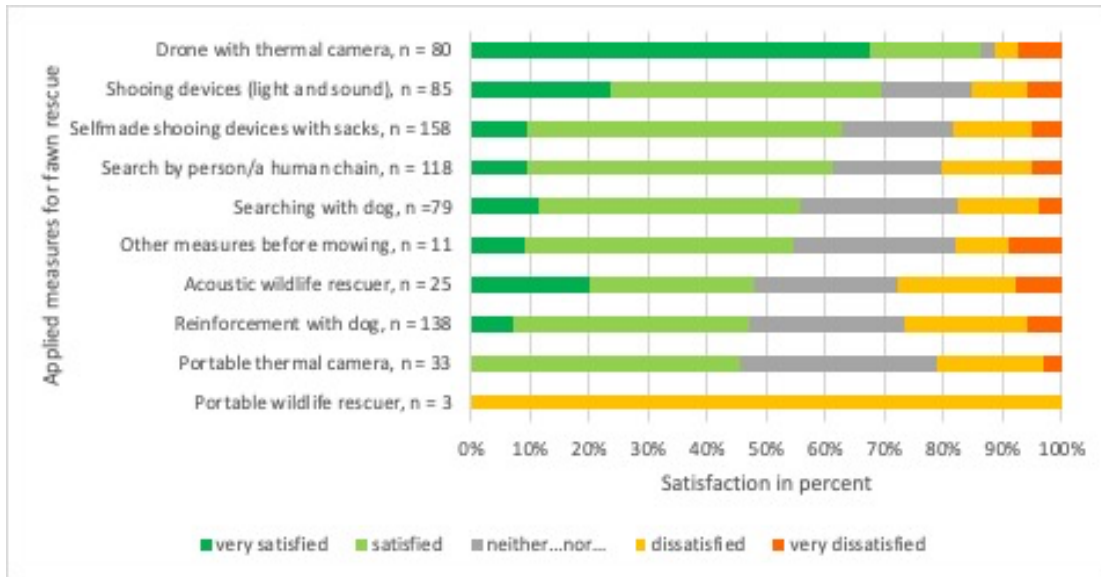


Figure 1: Satisfaction of hunters (n= 227) with single measures

Most hunters applied “simple” steps (i.e., self-made shooing devices with sacks, reinforcement. Moreover, hunters specified that most roe deer fawns got injured or were killed by mowers between 16th and 31st May during the last five years. All in all, in the previous five years, from hunters that applied measures themselves, 2118 fawns (n = 204) could be rescued on average every year, and 875 fawns (n = 207) were injured or killed during mowing within their hunting ground.

Conclusion: Wildlife rescue measures are a vital tool to prohibit roe deer fawns from mowing death. But there was no measure that all hunters would be satisfied with. Technologies the hunters were most satisfied with have been purchased the most during the last five years. However, fawns were injured or killed despite applied measures. More results with detailed information will be presented at the conference.

ABSTRACTS OF THE 15TH PERDIX CONGRESS

Understanding human and social dimensions of partridge conservation and management in Central-Eastern Europe [Keynote speech]

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The grey partridge (*Perdix perdix*) was once the most emblematic bird of the farmed landscape throughout its range. Conventional intensification of agriculture has led to a biodiversity crisis that is unresolved and worsening to this very day, despite the greening efforts of agricultural policies. The dramatic decline of the grey partridge – an ideal barometer for a healthy countryside - started almost half a century ago, with a 94% decline across Europe by 2020, caused by the intensification of modern agricultural practices and its underlying agri-policies. The grey partridge is not only one of the most emblematic, but also one of the most studied birds of the farmed landscape. Researchers have pinpointed the causes of decline and a combination of effective measures to reverse the trends were demonstrated at multiple sites, yet the examples of harmonious land-use envisioned by Aldo Leopold almost 90 years ago do not translate to wide scale uptake of sustainable practices, especially in Central-Eastern Europe. There are noticeable differences in attitudes of farmers, hunters, conservationists, policymakers and even the general public within different countries. Where do these differences stem from? Apart from the obvious differences of varying game management systems and hunting traditions, it is hard not to notice the gap between former Eastern Block countries and the rest of Europe. The failed social experiment of communism completely uprooted rural societies and left scars that are clearly visible even after three decades. Memories of forced collectivisation are vivid, farmers are suspicious of collective landscape scale approaches even in habitat management, making farm clusters difficult to establish. Strong habituations of industrial socialist agriculture are present to this day in everyday practices. This generation of farmers or agricultural entrepreneurs lack the experience of passing the farm from one generation to another, therefore recruitment of young farmers is even poorer than in many other regions of Europe. In this scenario, the short-term profit is more attractive than the long-term gains of sustainability which contradicts efforts to maintain a healthy countryside and society that is able to maintain a diverse landscape.

Sustainability is a subject viewed from many different perspectives by stakeholders, like the anecdotal elephant by a group of blind men. A better understanding of the human and social dimensions of grey partridge and farmland wildlife conservation is key in tailoring workable policies and actions to local circumstances. The “Perdix community” based on its holistic, balanced understanding of the arable farmland biodiversity crisis, plays a crucial role in creating harmonious and workable practical solutions based on a multidisciplinary approach that work for both the farm business and its wildlife.

Genetic introgression in red-legged partridge farms and an open platform system for discrimination between *Alectoris rufa* and *Alectoris chukar*

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The red-legged partridge (*Alectoris rufa*) is one of the most emblematic game species in Southern Europe. Its natural populations have experienced a decline during the last decade due to multiple factors such as habitat loss, agricultural intensification or hunting pressure. To cope with hunting demand, captive breeding in farms and releasing into the wild have increased. Although existing legislation prohibits the release of alien species, partridge farms may have some of their stocks hybridized with the chukar partridge (*Alectoris chukar*) due to historical practices. For this reason, the government of Andalusia region (Southern Spain), in collaboration with the Wildlife Research Unit (UIRCP-UCO), utilized a procedure based on species-specific SNP (Single Nucleotide Polymorphism) markers for checking the genetic status of partridge farms prior to issuing the permits for restocking in hunting areas. By this procedure we have analysed 8,857 individuals from 52 Andalusian farms, which resulted in an overall percentage of hybrid birds of 23,85%. Out of the 52 farms analysed, 41 presented a percentage of hybridization of the specimens higher than 5%. The results obtained from this survey indicate that there is a hybridization problem in the farms that release specimens to the field and that it must be controlled. The above-mentioned analysis system, based on SNaPshot® technology, presented technical complications that could have been eliminated with the use of open medium-scale genotyping platforms. For this reason, we present an improvement of the genetic analysis technique by using an open platform system to optimize the diagnostic procedure. The Open Array genotyping plates indeed offer a public and agreed control system that is able to detect genetic introgression between *Alectoris rufa* and *Alectoris chukar* with high performance, specificity, an ease of reproducibility compared to conventional techniques of genotyping.

The Rotherfield demonstration project – recovering grey partridges from zero

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Between 2010 and 2020 the Game and Wildlife Conservation Trust's Rotherfield demonstration project in southern England showed how to recover grey partridges in an area where they disappeared in the early 1990s and to showcase how grey partridge conservation management benefits farmland wildlife more generally.

During the 11-year period, the amount of high-quality grey-partridge friendly habitat within the 217-ha core area, mostly part of England's Higher-Level Agri-Environment Scheme (wild bird seed mixes, cultivated uncropped margins, beetle banks, floristically enhanced grass margins and field corners, pollen and nectar mixes and extended overwintered stubbles) increased from 10.4 ha (5% of arable area) to 43.3 ha (20%). During the same period, cropping was diversified and fields made smaller, resulting in a mixed arable crop pattern. Meanwhile, game management was intensified, focusing on predation management during the breeding season from early May to mid-July and supplementary winter feeding from September to the end of April.

The number of grey partridge pairs remained unchanged (17 pairs in 2010 vs 16 pairs in 2020), with a peak of 27 pairs in 2019. However, in 2010 almost all birds were released (17 pairs produced only 7 young; a young-to-old-ratio of 0.5), whereas from 2014 onwards all were wild. With 36 young recorded in autumn 2020 (young-to-old ratio of 1.8), the ratio was slightly higher than the 11-year average of 1.4. The peak year for productivity was 2014 with 79 young produced by 13 pairs (young-to-old-ratio of 3.2). The autumn stock of the re-established wild grey partridge population (no release of reared or wild birds since 2014) was 56 in 2020, with highest autumn numbers of around 100 birds recorded in 2014, 2017, and 2018.

In 2020, the breeding abundance of farmland songbirds on the UK's Amber and Red lists of Birds of Conservation Concern (yellowhammer, skylark, linnet, dunnoek, song thrush, bullfinch and tree pipit) was 93% higher than in 2010 in the project area, whereas nationally they increased by only 1% during almost the same 10-year period (see BTO BirdTrends for England). Similarly, brown hare numbers increased 1.8-fold, from an average of 23.5 hares/100 ha in 2017 to 42.0 hares/100 ha in 2020. Monitoring of hares began only with the start in 2017 of the EU-Interreg North Sea Region PARTRIDGE project.

Between 2011 and 2020, the number of shoot days per season averaged 12 (6 driven days including walk-stand days for 16 guns, and 6 mixed walked-up days including spaniel and pointer trial days), with an average annual mixed bag of 382 head of feathered game (SE 38.6),

of which 290 (SE 24.6) were cock pheasants. Of 600 wing-tagged cocks that were released annually, 153 (SE 18.4) were shot per season. Hence, the known recovery rate of released cocks in the bag was 25.5% (SE 1.1), whereas the recovery rate based on total cock bag was 47% (SE 4.5).

How to engage the public and influence policy aims in conservation projects: The NSR PARTRIDGE project as case study

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The PARTRIDGE project is a cross-border North Sea Interreg project that demonstrates how to reverse the ongoing Europe-wide decline of farmland wildlife using science-based management plans based on a bottom-up approach. The project is led by the GWCT, England in partnership with 12 partner organisations from seven nations (Scotland, England, the Netherlands, Belgium, Germany and Denmark). The partnership works with more than 70 farmers at 10 demonstration sites, assisted by around 40 hunters and several hundred volunteers. The project's two main aims are: 1) to demonstrate how farmland biodiversity can be increased by 30% by 2023, by implementing management measures tailored specifically to the grey partridge (*Perdix perdix*), 2) to embed at least one PARTRIDGE management measure into national agri-environmental policy in each project country.

The project's demo site managers held 184 farm walks to engage the local stakeholders at the 10 demo sites (farmers, hunters, farm advisors, NGO's, local, regional, and national agri-policymakers and influencers), informing more than 2700 people directly since the project began in 2017. Farmer and hunter clusters have been initiated at seven demo sites, with continuous efforts made to promote dialogue between the key stakeholders. The project runs an intensive media campaign, having reached an estimated 8,4 Million people via the printed press, social media (Facebook, Twitter and Instagram), PARTRIDGE's official webpage (<https://northsearegion.eu/partridge/>), regional & national TV and Radio and direct engagement to inform the public more widely about the farmland biodiversity crisis and how to address it. A strategically selected Steering Committee is assisting the project partners with its communication strategy.

The project's partners actively lobby for the inclusion of the project measures into future AES to ensure that the project's measures and approach find their way into policy across the NSR. Key events to help achieve this are national and international partridge symposia, the EU Green Week, EU parliamentary intergroup meetings and 1:1 meetings with policymakers. Thanks to this approach, beetle banks and PARTRIDGE flower mixes are now part of the Dutch AES, with good progress towards achieving the same in Flanders. In England, the PARTRIDGE mix has been included as a new option in the trial Scheme for ELMS. To date, 770 farmers have planted the PARTRIDGE flower mix in and outside the 10 demo areas and more than 32 km of beetle banks have been built as a result of the project.

What does socioeconomics bring to the conservation party: The NSR PARTRIDGE project as case study

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The PARTRIDGE partners undertook 74 in-depth structured interviews of stakeholders (farmers, high-level policy makers, farming advisors and farming representatives) across five countries (Scotland, England, the Netherlands, Belgium, and Germany) in 2019-2020. The interviews followed a set of the same twelve questions, designed to explore attitudes and opinions of the interviewees on agri-environmental schemes (AES), the advice and documentation available to farmers to maximise benefits for the environment and to highlight

suggestions for future development of the schemes. The results of these interviews were used to design a larger online survey across farmers in all countries where PARTRIDGE works. Additionally, four national reports were written, summarising the results of these interviews and a transnational one is being finalised, allowing for comparisons between countries. The results of these interviews/reports were useful beyond the development of an online survey and have helped PARTRIDGE project partners to better engage with both farmers and policy makers, as well as highlighting differences and similarities in AES provision between the different countries. This is allowing PARTRIDGE partners to effectively contribute to discussions at a national level in negotiations over developments for CAP and post-Brexit agricultural support for conservation measures directed towards grey partridges and other farmland flora and fauna.

Title: Regional and local factors affecting population dynamics of Grey Partridges (*Perdix perdix*): implications for conservation

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We assessed population dynamics of a Grey Partridge metapopulation (no shooting, no releases) split into 12 local populations in central Germany from 2006 to 2021. We expected a synchrony in population dynamics of local populations as described in literature due to weather conditions.

We investigated partridge population dynamics at an area in Central Germany, close to the town Göttingen. The area has a size of about 90 km. We divided the study area into 12 local plots of 3-12 km² size. The borders of local plots were defined by landscape structures interrupting the farmland habitat such as forests, villages, highly frequented roads and water bodies. Exchange between local populations is justified by radiotracking. We counted calling partridge cocks responding to playback calls along 86 transects of about 1.5 km length each in February and March 2006 - 2021. To investigate the degree of correlation of the annual change in Grey Partridge population numbers across the 12 subpopulations, we compared the sum of the single variances with the variance of the regional population.

On the scale of the whole metapopulation population size was relatively constant. On average, the estimated size of the metapopulation changed by 34% from year to year. On the locale scale, population sizes varied much more. The extent of the variance is much greater in the local populations than in the total population and a large part of the fluctuations occur asynchronously. The average annual change for each local population was 80%. Some declines and increases were synchronous across most local populations but never included all

populations. These synchronous events caused changes at the metapopulation level as well. However, most changes within local populations were asynchronous. The test for temporal autocorrelation of population size changes between the subpopulations showed a consistently negative outcome.

We concluded that the strong local population dynamics is not mainly driven by weather, but by local factors. We discuss these local factors as changing local predation levels. We conclude that partridge conservation on the scale of local populations experience a high risk of local extinction. Conservation on a larger spatial scale is more effective in this area.

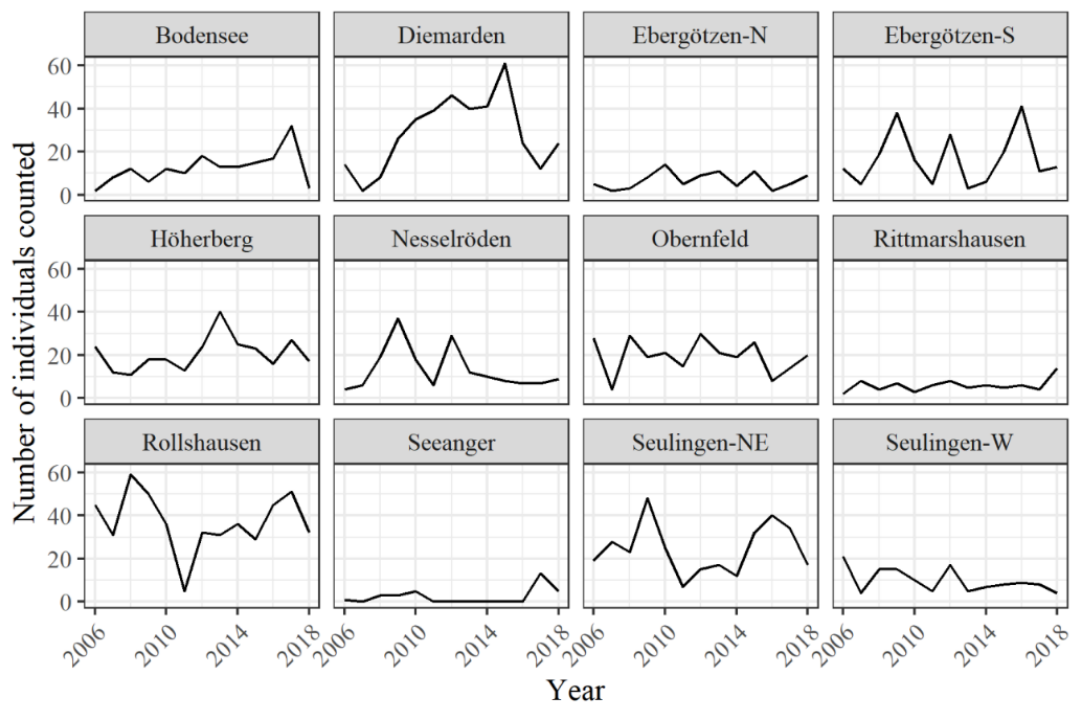


Figure 1: Changes in numbers of responding Grey Partridge cocks in the local plots within the regional population, Göttingen, Central Germany

Stay connected: forest corridors promote Hazel grouse (*Tetrastes bonasia*) occurrence in a fragmented landscape

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Forest fragmentation decreases the size of subpopulations and the probability of successful individual dispersal between subpopulations and is therefore considered as a major threat for Hazel grouse (*Tetrastes bonasia*) in central Europe. Identifying the corridors connecting their

habitat and evaluating to what extent these corridors favour habitat suitability would provide insights for its conservation.

We developed a habitat quality index for 29 study sites (~50 ha each) in the Western Swiss Prealps by mapping and quantifying the density of conifers identified as potential roosting sites during winter and the presence of food resources. In addition, we used published telemetry data, information on forest cover and circuit theory to quantify the relative resistance to dispersion of open areas compared to forests. These analyses allowed us to quantify the connectivity of each study sites using the programme Circuitscape and highlight dispersal corridors spreading within the study area.

We assessed the influence of habitat quality, measured as the area of suitable habitat within study sites, and connectivity, measured as the relative resistance to dispersal between study sites, on the occurrence of Hazel grouse in the 29 study sites. Factors affecting habitat quality were tested separately and in combination using logistic regressions and included indices of species presence collected during winter prospection as response variable. Because other grouse species occurred in the study area, we analysed the samples collected (faeces) using molecular tools to confirm the species and identify individuals.

The study emphasized that a threshold density of low-branched coniferous trees was a reliable predictor of habitat suitability for Haze grouse. Moreover, two dispersal corridors spreading within the Western Prealps were identified and mostly contributed to the connectivity among study sites. We also observed that study sites characterized by a high index of connectivity and an area of suitable habitat above the estimated threshold were more frequently occupied than isolated forest patches showing the same index of habitat quality. Our results suggested that habitat quality and connectivity are key factors explaining Hazel grouse occurrence and should be taken into consideration in forest management actions. Further research will assess whether Hazel grouse disperse along the predicted corridors by comparing genetic relatedness among individuals and landscape resistance to dispersal computed between sites.

Margins matter: the importance of field margins as avian brood rearing habitat in the intensive agricultural landscape

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The intensification of agriculture has had a significant impact on the habitat structure in agricultural landscapes and caused a decline in biodiversity worldwide, especially on farmland birds.

Birds are considered to reflect well the trends in other biodiversity elements and are therefore often used as indicator species. We studied Common pheasant (*Phasianus colchicus*) broods' (n=15) habitat use on small grain dominated farmland in southern Finland during the first four weeks after hatching with radiotelemetry (456 observations). The study was conducted during four consecutive years at the same location with translocated wild and hand-reared pheasant hens. The area was characterized by forest interspersed with open agricultural landscapes. All field patches in the area were subsurface drained and separated from one another by open ditches that also provide field margin habitat with herbaceous vegetation and occasional willow stands (*Salix* spp.). The average field patch size was 5.8 hectares, providing 15 km margin/100 ha.

Habitat analysis by compositional analysis revealed that the broods preferred field margins significantly compared to their availability. Comparing the observations on grain fields, the most used habitat, to the distance to field margin by five-meter-wide buffer zones underlined the importance of margins: 68% of observations on grain fields were inside a 25-meter-wide zone from the edge of the field, despite the availability being 40%.

Our results support the idea of field margins and their proximity as possible biodiversity reservoirs even in intensive farming. Changes in agricultural policy towards favoring the biodiversity-boosting effects of margins and their surroundings are not necessarily in conflict with high-yield farming. For example, the restricted use of pesticides under 25 meters from field margins would benefit biodiversity while still leaving plenty of room for chemically enhanced crop production. Identifying key habitats and landscape features that allow co-existence of biodiversity and effective food production, is crucial when aiming to halt the ongoing biodiversity collapse.

Environmental aspects of the grey partridge (*Perdix perdix*) in the forest-steppe agricultural landscape of the Ukraine

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We investigated the environmental aspects of grey partridge abundance across the natural-agricultural zones of the modern forest-steppe of the Ukraine. Grey partridge numbers did not show widespread significant correlations with climatic factors, in the areas studied. The only two found were in the Poltava region, where there was a marked negative correlation between the number of birds and average rainfall in June, and in the Khmelnytsky and Vinnytsia regions, where there was a - positive correlation with average annual humidity. We found a negative

relationship between the density of roads and partridge numbers on hunting lands in all provinces, significant in the case of provinces with the right-bank Forest Steppe habitat. There were more negative associations with grey partridge numbers and factors associated with agriculture in the central and left-bank forest-steppe of Ukraine. These factors included the area sown with crops in general, and with specific crops (corn, sunflower and soybeans), the area of human habitation, and measures of mineral fertilizer and pesticide use. In contrast to this there were positive but not significant relationships with these factors and grey partridge numbers in the western part of the region. This may reflect a relationship between grey partridge numbers and changes in the mosaic of natural habitats and agricultural landscapes that are evident as one moves from the west to the east of the modern Ukrainian steppe.

Further information is needed on how grey partridge numbers are affected by the management of hunting in the agricultural landscapes of the regions studied here. This management includes identifying the number and importance of artificially reared birds, the provision of ecological and economic measures for the conservation of grey partridges and the management of harvest rates.

Migratory and phenotypic polymorphisms in common quails are associated with a large chromosomal inversion

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Chromosomal rearrangements are known to play an important role in the coexistence of diversification within some species. Using genomic and immunofluorescence analyses on individuals from nine populations, we discovered a large chromosomal inversion (affecting 12% of the genome) in individuals from the western limit of the range of the Common quail (*Coturnix coturnix*). The analysis of around 120 individuals showed that birds with the inversion are heavier, have darker throat coloration, poorer flight efficiency, and a restricted geographic distribution. Stable isotope analyses of feathers developed in wintering and breeding grounds showed that quails with the inversion have very reduced migratory movements or do not migrate at all. The inverted haplotype may have arisen by introgression from a species that existed in that region and became extinct during Holocene human expansions. Despite high mobility of the species as a whole, the two forms coexist and interbreed in a potentially small area within the range of common quails. However, the precise distribution of this chromosomal rearrangements remains unknown.

Conservation needs people: engaging with the public and policy makers using the grey partridge (*Perdix perdix*) as the driving factor

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Successful conservation of biodiversity in the agricultural landscape is not possible without the involvement of local residents, organizations and governments. This reflects the fact that farmland biodiversity is highly influenced by agricultural practices, rural developments and leisure activities. In recent decades, these human interventions, and the pressure they apply to flora and fauna on farmland has only increased, especially in Western Europe. This is reflected in the Netherlands, where agriculture has been highly modernised, and urbanisation is taking its toll on the environment and biodiversity. Many people who grew up in the 'old' agricultural landscape experience this as a great loss. People feel a strong connection with the landscape where they live and work. This connection is typically stronger than the connection many feel for nature reserves. Creating support for the value of farmland biodiversity by working with a wide range of local stakeholders is key to achieving conservation success in this setting.

The North Sea Region Interreg PARTRIDGE project, a collaboration of 12 partner organizations, is using a bottom-up approach, with the conservation of the grey partridge as the driving interest, to engage and motivate rural stakeholders to work together to restore farmland biodiversity. The project managers at the 500-ha PARTRIDGE Oude Doorn demo site in the province of Brabant, the Netherlands, are putting an emphasis on communication activities and engagement events to achieve the project's main aim - an increase of farmland biodiversity across a farmer cluster of almost 30 farms. The project managers encourage intensive knowledge exchange, instigate profound and constructive opinion sharing, organize stakeholder-tailored farm walks, celebrate conservation successes and, above all, partake in the consumption of a lot of coffee to create a sense of ownership and pride among all stakeholders. The stakeholders involved in this cooperative effort range from volunteers from the general public, bird watchers, hunters, conservationists, representatives from local, regional and national authorities, policymakers and politicians.

This talk will explain how the project came about and will provide real-life examples of the actions that were necessary to achieve a conservation legacy beyond the PARTRIDGE project's lifespan.

Challenges and solutions in monitoring biodiversity and ecosystem service trends

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Monitoring biodiversity and ecosystem service trends for longer periods of time has its own challenges and pitfalls. Choosing what monitoring method to use, how to gather the data, the interpretation of the results, the whole process can be strenuous and time-consuming. However, if done correctly, monitoring biodiversity and ecosystem service trends can provide valuable information to researchers and policymakers on population dynamics and management of the monitored areas.

The European PARTRIDGE project (<https://northsearegion.eu/partridge/>) aims to show how new and enhanced management solutions can improve biodiversity and ecosystem services up to 30% by 2023. The flagship species is the Grey Partridge (*Perdix perdix*), although the Hare (*Lepus europaeus*), breeding and overwintering farmland birds and insects (proxy for pollination and natural agricultural pest control) are also monitored. The project consists of ten demonstration sites of 500 ha each in Belgium, England, Germany, Scotland and The Netherlands (two in each region). In each demo site, agri-environment schemes (AES) were established on at least 7% of the area, together with winter feeding and predation management where legally possible. All ten demonstration sites have a corresponding control site without extra measures.

The first challenge to overcome when monitoring several project areas in multiple countries is the difference between the project sites. The used monitoring methods need to result in comparable data but at the same time adapted to the local situation of every project site. For instance, we used both point counts and line transect counts to monitor the hare populations.

Second, monitoring all of those species and ecosystem services in twenty project sites (ten demo sites + ten control sites) spread across Western Europe is evidently not a one-person job. Several

researchers, field workers, farmers, hunters, conservationists and volunteers have to work together to gather all of the data. Working with so many people from different backgrounds and with different ideals is undeniably a challenge.

Third, species abundances and ecosystem services are influenced by numerous variables like weather, species dynamics, hunting and agricultural practices. For example, we need to know if and to what extent the species that we monitor are hunted in each project site and take that information into account when looking at our results.

In this presentation, we will discuss the pitfalls and difficulties we identified working on this large multi-country, multi-stakeholder project, whilst also sharing solutions that we found have worked for us.

The effect of Ecological enhancements on breeding densities of Galliform farmland birds

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Although the Grey Partridge, *Perdix perdix*, has the status “least concern” on the European Red List, the population trend is decreasing, as is the case for many other farmland birds. In some countries population levels dropped so far that the Grey Partridge is listed as endangered or vulnerable on the national Red Lists. To reverse biodiversity decline, agri-environmental schemes (AES) have been introduced to restore suitable habitats for species where they can forage, nest, reproduce, and/or overwinter. In the scope of the European PARTRIDGE-project (<https://northsearegion.eu/partridge/>) the environment was enhanced with AES up to 7% or more of the area in ten 500 ha demo sites in Belgium, England, Germany, Scotland and The Netherlands (two in each region). This was supplemented by winter feeding and predation management where local circumstances allow. The aim was to improve biodiversity and ecosystem services by up to 30%. Each demo site was compared to a control site without extra measures. Here we report on the effects on the Galliform species Grey Partridge (*Perdix perdix*), the main target species, Common Pheasant (*Phasianus colchicus*) and Common Quail

(*Coturnix coturnix*). Breeding birds were monitored by territory mapping from 2017 till 2021. Each area was visited at least 5 times during the breeding season. The results show that there are significantly more territories in the demo sites than in the control sites for Grey Partridge and Common Pheasant. Interesting to note is that also for some other threatened farmland species like Yellowhammer (*Emberiza citrinella*) and Skylark (*Alauda arvensis*) more territories are present in the demo sites than in the control sites.