XIV Congresso Italiano
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ABSTRACT BOOK

Abstract Book

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Invited speakers

INVITED SPEAKERS

Squeezed upwards: Building an evidence-base for mountain ecosystems management from movement and behaviour data

Börger L.[1]

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Human actions are increasingly pushing Earth's systems beyond sustainable function. Under such rapidly changing environmental conditions robust predictions are needed for evidence-based management and policy decisions. Animal movements and behaviour drive major ecological processes, yet are still underutilized to inform policy and management decisions. To improve this, we must change from a descriptive to a predictive science, focussing on mechanisms. Here I present recent research with our colleagues on wild and domestic ungulates in the French Alps, focussing on three processes – movement responses to human disturbances affecting the landscape of fear; the cost of movements and energy landscapes in mountain areas; and the role of spatial context in behavioural responses of mountain ungulates to heat stress. Animals generally respond to human activities with fear-induced proactive behaviours. However, animals are often exposed to co-occurring and difficult to distinguish lethal and non-lethal disturbances, creating a complex landscape of fear. We developed a conceptual framework relying on the risk-disturbance hypothesis and habituation to predict tolerance adjustments under various disturbance contexts, and implemented it using data from GPS-tracked chamois (Rupicapra rupicapra rupicapra; 89 individual-years) in areas with co-occurring and seasonally varying hunting, hiking and skiing disturbances. Focussing on diel migration (DMs) responses between risky places during safe nighttime and safer places during risky daytime, we found that ~85% of chamois moved away from trails during daytime, especially during the hiking and hunting periods, with an increased tolerance, suggesting habituation, among the most disturbed diel migrants, and shorter DMs in areas highly disturbed by hikers. Compared to hiking, hunting exacerbated the threshold distance to trails triggering DMs. Crucially, the most human-habituated chamois during the hiking period remained more tolerant in the subsequent harvesting period, potentially incurring increased hunting risk, whilst individuals less tolerant to hiking performed longer DMs when hunting risk increased. Thus, complex human-induced landscapes of fear may shape unexpected patterns of tolerance to human activities, whereby animal tolerance could become potentially deleterious for individual survival.

Cost of transport (COT) considerably impacts endothermic species energy expenditure, but may strongly vary by species and terrain. Using multi-sensor high-frequency biologging data from six mountain ungulate species (30 – 600 kg body size), we showed that animals travelled obliquely to topographic slope and generally slower on steep inclines, with travel speed and slope overall affecting COT, further depending on habitat (surface) type. Species differences in choice of travel speed and slope were marked, with striking differences especially for chamois. Our results provide fine-scale species-specific energy landscapes for ascent and descent and highlight the importance of quantifying movement in 3D and the complexity of factors affecting space use

by mountain ungulates.Time and energy allocation to thermoregulation is expected to increase globally, but thermoregulatory responses may be complex and context dependent. We analysed HMM-derived individual time-budgets and daily habitat use of 26 GPS-tagged females monitored during summer, showing heat stress avoidance behaviours above a threshold temperature of 17.8°C. Use of forest and northern slopes increased by 2.8% and 2.2%, respectively, for each 1°C increase in temperature. Individuals with access to forests within home ranges also increased daily time spent foraging, while individuals with access to northern slopes increased the time spent relocating at the expense of foraging. Including local landscape context and jointly analysing resource selection and behavioural activity is hence key for improved insights into nuanced changes in individual responses to climate change in different spatial contexts, and provides an evidence base to identify and protect key thermal cover habitats. I conclude discussing future directions for research on mountain mammals.

The overlooked mammal: Why humans should be part of conservation studies

Glikman J.A.[1]

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Human–wildlife interactions are becoming increasingly frequent and complex as human activities continue to transform natural habitats and wildlife increasingly adapts to human-dominated landscapes. Climate change is further intensifying these dynamics by altering species distributions, resource availability, and the behavior of both humans and wildlife, creating new challenges for conservation and management that cannot be addressed through ecological and biological perspectives alone. Despite this, conservation and management of mammals have traditionally focused primarily on ecological processes and species biology, often overlooking one of the most influential components of conservation systems: humans themselves.

In this introductory lecture, I will explore the role of human dimensions in mammal conservation, emphasizing how perceptions, values, behaviors, and socio-economic conditions shape interactions between people and wildlife, as well as relationships among people involved in conservation processes. Through examples from different regions and case studies involving mammals from around the world, I will show how a human dimensions approach provides a more nuanced understanding of human–wildlife conflict and coexistence by linking ecological processes with broader social, cultural, economic, and political dynamics. Rather than viewing conflict solely as direct interactions between humans and mammals, this perspective highlights the multiple viewpoints, power dynamics, and social complexities underlying conservation challenges, while also recognizing opportunities for coexistence and collaborative management.

Particular attention will be given to the diversity of social science methods used in conservation research, ranging from qualitative and quantitative interviews, to participatory approaches, and co-production processes. These examples will illustrate how different methodologies can help reveal local knowledge, lived experiences, and diverse perspectives that are often overlooked in conservation planning. The lecture will further discuss how integrating disciplines such as psychology, sociology, economics, and political science into conservation can support more inclusive, participatory, and socially just approaches involving local communities and different interest groups. By integrating ecological and social perspectives, this contribution argues that effective conservation requires recognizing humans not as external pressures on ecosystems, but as an integral part of conservation systems themselves.

From Balkan caves to African rainforests: Challenges and lessons from studying bats across continents

Budinski I.[1]

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Bat populations worldwide are increasingly affected by habitat loss, landscape transformation, and human disturbance, and many species remain poorly studied due to their nocturnal behaviour, cryptic morphology, and the practical challenges of field research. Despite increasing scientific attention toward bats and their conservation, important gaps still exist in our understanding of species distributions, movement patterns, roosting ecology, and population structure.

My research initially focused on horseshoe bats in Serbia and neighbouring countries, where I investigated population genetics, phylogeography, and movement ecology of several conservation-priority species. This work revealed moderate population structuring in the Mediterranean horseshoe bat and identified the Balkans as a potential glacial refugium for the species. During extensive field surveys and regional collaborations we discovered seasonal movements of two bat species between Serbia and Romania and gathered distribution data for nearly all bat species occurring in the region. Alongside ecological research, I contributed to the development of low-cost molecular identification methods aimed at reducing misidentifications among morphologically similar horseshoe bat species and supporting broader monitoring and conservation efforts. Long-term fieldwork also highlighted the importance of transboundary collaboration, particularly for species that depend on networks of roosts distributed across multiple countries.

Over time, international collaborations and field-based research gradually expanded my work toward African bat communities, where tropical ecosystems present both extraordinary diversity and additional logistical and scientific challenges. My current research focuses on cryptic diversity, species limits, habitat associations, and biogeographic patterns in African bats, combining genetics, acoustics, morphology, and extensive field sampling across understudied regions. Working across different continents and research systems has also emphasized the importance of integrating local ecological knowledge, international collaboration, and multidisciplinary approaches in biodiversity research.

My experiences across regions have highlighted how strongly bat knowledge gaps are linked to local research capacity and broader socio-economic and political history, and how this can delay the development of the baseline data that ecological research depends on. They also demonstrate how local studies can grow into broader international research networks and contribute to larger questions in ecology, evolution, and conservation biology.

SESSIONE 1.

Ecologia e conservazione dei mammiferi in un mondo che cambia

At risk and overlooked: The silent decline of the garden dormouse in Europe

Bertolino S.[1]

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In Europe, species conservation priorities are largely defined by the annexes of the Habitats Directive, which strongly influence research agendas, management actions, and funding allocation. As a result, conservation efforts tend to focus on a limited number of high-profile and charismatic taxa, such as large carnivores. In contrast, many less conspicuous species remain long neglected and are declining unnoticed, vanishing in plain sight. The garden dormouse is one of them. By relying on decades-old records, distribution atlases and data reviews may portray species as still present long after they have disappeared. These legacy data are then incorporated into European evaluations and large-scale Red List assessments. This is precisely what has happened in several countries, where the garden dormouse was reported as still present despite having already gone locally extinct. The aim of this work is to review the conservation status of the garden dormouse across Europe.

Within Mammal Conservation Europe, a network of national organisations dedicated to the study and conservation of mammals, we brought together experts from all European countries where the species is currently or was formerly present. We conducted a comprehensive review of both peer-reviewed and grey literature. The geographic and linguistic diversity of the author team enabled us to overcome language barriers and incorporate information published in local languages across all relevant countries.

The garden dormouse is currently considered regionally extinct across large parts of its former range, including Estonia, Finland, Latvia, Lithuania, Slovakia, Belarus, Poland, and Ukraine. In several additional regions, the species is facing a high risk of extinction and is classified as Endangered or Critically Endangered, notably in the Czech Republic, Flanders (Belgium), Germany, and the Netherlands. Even in Western Europe, an area traditionally regarded as a stronghold for the species, the conservation status of the garden dormouse is deteriorating. It is currently listed as Near Threatened in Portugal and Italy, and multiple sources report local population declines or recent extinctions in Spain, France, and Switzerland. Together, these patterns indicate a widespread and ongoing contraction of the species' European range, affecting both peripheral and core areas.

The contraction of the garden dormouse's range in central and eastern Europe remains only partially explained and is likely driven by multiple interacting pressures, including insect decline (a key food resource for the species), rodenticide exposure, and pesticide bioaccumulation. Studies from Germany reveal widespread contamination with DDT, PCBs, and numerous other pollutants, which may impair reproductive success. Despite regulatory bans, DDT use appears to have persisted in Eastern Europe until the 1980s, with possible illegal applications continuing thereafter. The garden dormouse ranks among the European mammal species that have experienced the most severe range contractions over recent decades. Despite this alarming trend, and in contrast to other glirid species listed in the annexes of the Habitats Directive 92/43/EEC (e.g. the hazel dormouse and the forest dormouse), the garden dormouse is not currently recognised as a conservation priority under European legislation. As a result, the species is largely overlooked in national conservation frameworks, monitoring programmes,

and targeted funding schemes, leading to substantial gaps in knowledge and management across much of its range. This mismatch between conservation status and conservation action highlights the urgent need for a coordinated, Europe-wide action plan. Such a framework should integrate standardised monitoring, threat mitigation, and habitat management, and be supported by the rapid implementation of evidence-based conservation measures. Priority actions should include a rigorous assessment of the feasibility of reintroduction or reinforcement programmes in peripheral areas of the species' range, particularly in regions where populations are small, highly fragmented, or have recently undergone local extinction. These efforts should be embedded within broader landscape-level strategies aimed at restoring habitat connectivity and long-term population viability.

Global patterns of niche changes in alien mammals: potential drivers and significance for invasion projections

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Human-assisted dispersal of alien species is a major component of global change, reshaping mammal communities worldwide and causing pervasive impacts on native biodiversity. Bioclimatic Species Distribution Models (SDMs) are widely used to support prevention by mapping potential invasion risk, but they often assume that species conserve their realized native climatic niche after introduction. We tested this assumption for established alien mammals at global scale by quantifying native–alien realized climatic niche divergence, identifying its correlates, and evaluating its implications for the reliability of SDMs in invasion-risk assessment. We analysed 194 alien mammal species established across 11 zoogeographic realms. For each species, we compared the native niche with the realm-specific alien niche, yielding 337 species-by-realm niche comparisons. We used an ordination-based niche framework that summarizes climatic variability on the first two axes derived from 19 bioclimatic variables, applies kernel smoothing to occurrence densities to make niches comparable despite unequal range sizes, and partitions niche change into niche expansion (climatic conditions occupied only in the alien range), niche stability (climatic conditions occupied in both ranges), and niche unfilling (climatic conditions occupied only in the native range). We then used Generalized Linear Mixed Models with an information-theoretic multi-model inference approach to test how species attributes, invasion history, and environmental context relate to niche expansion and unfilling. Finally, we evaluated the transferability of SDMs calibrated with native presences to receiving zoogeographic regions, using multiple performance metrics, and modelled how niche expansion and unfilling can affect SDM transferability under comparable climatic space. Across realms, niche expansion was rare and generally modest (median = 0.0002, standard deviation = 0.267), whereas niche unfilling was widespread and often pronounced (0.76, 0.33). Expansion at or above 0.1 occurred in 79 of 337 alien ranges (23.4%) and in 54 of 194 species (27.8%) in at least one realm, while unfilling at or above 0.1 occurred in 300 of 337 alien ranges (89.0%) and 185 of 194 species (96.9%). Niche expansion decreased with increasing human disturbance, larger native range size, and greater community similarity between native and alien zoogeographic regions, and increased with increasing introduction effort. Niche unfilling decreased with increasing introduction effort and longer residence time, and increased with alien insularity, human disturbance, and native range loss. Native-SDMs generally transferred well to receiving zoogeographic regions, but performance declined with niche expansion because alien presences increasingly occurred outside native-like suitable conditions, and declined with niche unfilling for metrics sensitive to suitable but unoccupied areas. Bioclimatic species distribution models remain a robust basis for prevention and early warning in alien mammals, but their reliability depends on how fully alien populations have realised the native niche and whether they occupy conditions outside it. High niche unfilling points to large pools of suitable yet unoccupied climates, signalling invasion debt and justifying proactive surveillance, pathway management, and rapid response even when current alien ranges are small. Evidence of niche expansion, although less common, flags departures from native climatic constraints and therefore greater uncertainty in projections, calling for closer monitoring and more carefull interpretation of risk maps.

Recovering in isolation: dynamics of the Alpine brown bear population over two decades post-reintroduction

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Large carnivores have been extirpated from much of their historical range, but targeted conservation actions have recently enabled their recovery in several regions. The reintroduction of the brown bear in the central Alps represents a notable example, yet the long-term persistence of this population remains uncertain. Its small size, geographic isolation, and growing conflicts with humans pose significant challenges, highlighting the need for comprehensive assessments of population status and trends to inform management and evaluate its responses to environmental and anthropogenic changes.
Using individual genotypes collected non-invasively between 2003 and 2023 within a long-term monitoring program, we analysed population dynamics of the Alpine bear population through spatial capture–recapture, and survival modelling. By combining systematic and opportunistic sampling, we aimed at: obtaining spatially explicit estimates of population density and assessing its spatial drivers; assessing age- and sex-specific survival probabilities and site fidelity; and quantifying temporal variations in female range.
In 2023, population size was estimated at 105.6 individuals (95% CI = 91.6 - 121.8). Density has increased at an average annual rate of 7.7 %, with a mean density of 1.61 bears/100 km2 in the whole study area, and 2.50 within the area permanently occupied by females. Bear density also varied in space, being higher in proximity to the original release site and on steeper slopes. Survival probability varied by sex and age, and was lower for males and younger individuals. Site fidelity was highest for females, with no permanent emigration from the study area detected throughout the study period. Despite the high site fidelity, the area occupied by females has expanded substantially over time, increasing by 137% over two decades. However, this expansion remains confined to the western side of the Adige Valley, which represents a major ecological barrier and hinders connectivity with the nearest Dinaric-Pindos bear population.
Overall, our results indicate positive trends in both abundance and spatial expansion, but also emphasize persistent vulnerabilities linked to the relatively small size and isolation of this bear population. Female site fidelity emerged as a key determinant of population space use, as all density hotspots were located within areas consistently occupied by females. Observed spatial patterns seem to reflect the interplay between intrinsic biological traits and anthropogenic factors, including artificial barriers and human disturbance. Importantly, the integration of opportunistic genetic detections proved essential for reliable inference: excluding these data would have led to a 33% underestimation of population density in 2023 and a halved estimated growth rate. Sustained genetic monitoring, improved connectivity, and science-based management will thus be crucial to ensure the long-term persistence of this population in a human-dominated landscape and increasingly hostile social context.

Linking movement ecology and zoogeochemistry: red deer as drivers of nutrient redistribution in the Alps

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Animals function as dynamic vectors in biogeochemical cycles, actively transporting nutrients across ecosystems. However, traditional zoogeochemical models frequently oversimplify this role, treating animal inputs as static, spatiotemporally averaged stocks. This approach fails to account for the reality that movement explicitly dictates the timing and location of ecosystem interactions. As habitat fragmentation increasingly restricts mobility, understanding the mechanistic link between animal movement and nutrient cycling is critical.

We address this gap with a novel Agent-Based Model (ABM) that integrates movement ecology with landscape-scale nitrogen (N) dynamics. Our model couples high-resolution GPS trajectories of red deer (*Cervus elaphus*) in the Italian Alps with spatially explicit land-use and NDVI data. By utilizing empirical data on herd sizes, metabolic rates, and activity patterns, we simulate how migratory versus resident tactics influence N redistribution. We compare observed nutrient flows against scenarios where migration is lost to quantify how movement behaviors modulate biogeochemical heterogeneity.

Our analysis reveals that red deer act as essential mediators of nitrogen flux across multiple scales. Locally, foraging behaviors drive net nitrogen transfers from grasslands into forest patches. At the landscape level, migratory herds facilitate both vertical (altitudinal) and horizontal nutrient exchange, effectively connecting distinct ecosystems and buffering against nutrient accumulation or depletion. Conversely, resident herds in fragmented landscapes concentrate nutrients, increasing the risk of localized eutrophication. Furthermore, we identify anthropogenic barriers, such as roads, as significant obstacles that decouple these historical nutrient flows.

We conclude by evaluating the economic consequences of severing these migratory pathways, arguing that conservation strategies must explicitly incorporate movement ecology to maintain essential ecosystem functions in human-altered landscapes.

Genomic resilience in the Apennine chamois: insights from a genome-wide population survey

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Understanding how small, isolated populations persist despite the genomic consequences of demographic bottlenecks and inbreeding is a central challenge in conservation biology. Severe bottlenecks may expose recessive deleterious alleles and trigger inbreeding depression, yet long-lasting low effective population size can also facilitate the removal (purging) of strongly deleterious variants, potentially allowing persistence at the cost of an increased burden of mildly deleterious mutations.
The Apennine chamois (*Rupicapra pyrenaica ornata*) is an endemic and threatened mountain ungulate that experienced strong historical declines, persisting for decades as a single nucleus within the Abruzzo, Lazio and Molise National Park and later serving as the source for reintroductions across the central Apennines. Here, we provide a first genome-wide assessment of genetic status in the source population, using reduced-representation sequencing data from individuals sampled during long-term monitoring. We evaluate population structure, genomic diversity, recent and historical inbreeding, and signatures of genetic load.
Our analyses indicate high genetic homogeneity across the sampled area, with no evidence of pronounced substructure. Despite past demographic contractions, the population retains moderate genome-wide variation and shows no signal of recent severe inbreeding. Patterns of homozygosity are consistent with a history of long-term small population size, dominated by older autozygous segments. In line with this demographic scenario, we find limited evidence for highly deleterious variation, whereas putatively mildly deleterious non-synonymous variants are present at appreciable frequencies, with functional signals pointing mainly to metabolic and developmental processes.
Overall, these results suggest a form of genomic resilience shaped by drift and purifying selection under prolonged small population size. The study establishes a baseline for integrating genomics into conservation planning and underscores the value of continued genetic monitoring to support management strategies under ongoing environmental change.

An integrated methodological approach reveals the coexistence of African and European bats on the Pelagian islands

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Islands represent exceptional natural laboratories for investigating biogeographical patterns, particularly when located at the boundary between major bioregions. However, island bat communities remain poorly studied due to logistical constraints and related survey challenges. The Pelagian Islands (Lampedusa, Linosa and Lampione), lying at the interface between the African and European bioregions, offer a unique opportunity to investigate bat diversity, biogeographical affinities and conservation relevance at the southern margin of Europe, while updating limited and outdated information.
Between 2022 and 2025, we investigated bat communities on the Pelagian Islands using an integrated approach combining automatic acoustic monitoring, roost inspections, molecular species identification from guano, and captures. Acoustic data were analysed to assess diversity, activity patterns and the influence of habitat features on bat activity.
On Lampedusa, we documented at least eight bat species, including taxa with predominantly North African distributions and marginal occurrence in Europe, such as *Rhinolophus mehelyi*, *Plecotus gaisleri* and *Myotis cf. punicus*, substantially updating previous literature records. Moreover, we detected the Maghrebian bent-winged bat *Miniopterus maghrebensis*, representing the first record of this north western African species in Europe, confirmed by DNA barcoding. Bat activity and diversity were primarily associated with temporary ponds and remnants of natural scrubland linked to watershed areas. In contrast, Linosa exhibited markedly lower species richness, with only two species confirmed, likely reflecting its small size. Nevertheless, we captured several individuals of *Pipistrellus* cf. *deserti*, currently considered an African morphotype of *P. kuhlii*, representing its first detection in Europe and contributing to its molecular and morphological definition.
Overall, our findings highlight the Pelagian Islands as biogeographical reservoirs and potential crossroads for bat fauna, emphasising the importance of Mediterranean islands for bat conservation in Europe.

Community reshuffling dominates mammal responses to urbanization in a changing world

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Urbanization is one of the most pervasive drivers of global change, rapidly transforming landscapes and reshaping animal communities. However, it remains unclear whether assemblages along urban gradients are primarily structured by selective species loss, driven by predictable extinction/colonization processes due to habitat loss/isolation and resulting in nested community patterns, or by species replacement, leading to turnover. We tested these alternative mechanisms in two mammal taxa characterized by contrasting ecologies and dispersal abilities: highly mobile volant bats and small, terrestrial mammals with limited movement capacity.

We sampled bat and small mammal communities along an urbanization gradient in the Metropolitan City of Milan (Italy). Bats were surveyed at 54 sampling plots using passive acoustic recorders (Audiomoth), while small mammals were sampled at 64 plots using hair-tubes. We quantified beta diversity and partitioned it into turnover and nestedness components. Additionally, we assessed true nestedness using NODF. Environmental and spatial drivers of beta diversity components were disentangled using distance-based Redundancy Analysis (db-RDA) and variation partitioning. Finally, we evaluated whether community patterns were driven by species-specific environmental responses and/or interspecific associations using Joint Species Distribution Models.

Beta diversity was high in both taxa and strongly dominated by turnover, whereas nestedness contributed only marginally. In both groups, community composition was primarily shaped by environmental gradients and shared spatial–environmental structure. The db-RDA showed that both bat and small mammal communities responded mainly to vegetation structure, while small mammals were also significantly influenced by urban-fabric characteristics. At the species level, turnover along the urban gradient was driven by a restricted set of species with contrasting environmental affinities. In bats, *Nyctalus noctula*, *Vespertilio murinus* and *Hypsugo savii* replaced each other along the distance-to-city-center gradient, while *N. noctula*, *V. murinus*, *Eptesicus serotinus* and the *Pipistrellus nathusii/kuhlii* group were associated with higher grass cover. In small mammals, *Erinaceus europaeus* typified peri-urban assemblages and, together with *Glis glis* and *Sciurus carolinensis*, replaced other species in relation to local habitat features. No credible interspecific associations emerged for either taxon.

Despite their contrasting ecologies and dispersal abilities, both taxa exhibited remarkably similar community-level responses to urbanization, with species turnover overwhelmingly dominating beta diversity. These findings suggest that community differences along urban gradients are not primarily driven by selective extinction/colonization due to habitat loss/isolation, but rather by the lack of suitable environmental conditions within urban and peri-urban green spaces. From a conservation perspective, enhancing urban biodiversity therefore requires targeted habitat restoration aimed at supporting disturbance-sensitive species - beyond favoring urban-adapted ones - in order to diversify ecological niches and maintain ecosystem functioning in an increasingly urbanized world.

Seeing the unseen: spatially explicit capture-recapture models to estimate roe deer (*Capreolus capreolus*) density

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Monitoring large herbivores in landscapes with high woodland cover is challenging because direct observation methods often suffer from low detectability, leading to biased estimates of population density. Identifying reliable and easily implementable alternatives for estimating population density under such conditions is therefore of key importance for wildlife management. Camera trapping has emerged as a valuable tool in these environments, particularly when individuals can be recognised, allowing population density to be estimated using capture–mark–recapture (CMR) approaches. Here, we take advantage of the fact that roe deer males can be individually identified by their unique antler morphology, to estimate population density using CMR.

The study area is located in the Po Plain along the Ticino River in the Lombardy region. It is characterised by a mixed landscape of alternating woodlands and cultivated lands and it is largely included in the "Valle del Ticino Lombardo Natural Park". Roe deer were surveyed using camera trapping over two consecutive spring seasons (2021 and 2022), with camera traps deployed in the field for an intended period of 120 days each year. Male roe deer were classified by age (juveniles:
<1 year; sub-adults: 1-2 years; adults: >2 years) and then individually identified based on antler morphology. Population density was estimated using spatially explicit capture-recapture (SECR) models. Because individual identification was not possible for all detected males, SECR-based density estimates were considered conservative and subsequently corrected using an empirically derived identification probability.

A total of 177 roe deer events were recorded (2021: n = 87; 2022: n = 90). No significant deviation from parity was detected in the sex ratio, which was estimated at 1.10 females per male. Overall, 56 male roe deer were individually recognised (2021: n = 29; 2022: n = 27). Identification probability was estimated as the proportion of male detections that could be reliably sexed and identified. Assuming that individuals of undetermined sex followed the same sex ratio as sexed individuals, we estimated that approximately 80% of detected males were successfully identified. A model assuming constant density and detection parameters across years provided an estimate of male density of 0.25 males per km2 (95% CI = 0.17 - 0.36). After correcting for the observed sex ratio and for incomplete identification, roe deer density was estimated at 0.74 ind. per km² (95% CI = 0.51 - 1.08).

Despite providing conservative density estimates, the proposed approach proved to be promising and readily implementable, offering a practical alternative for estimating roe deer population density in environments with high woodland cover.

Assessing temporal overlap, habitat preference and spatial co-occurrence in sympatric pine martens and stone martens

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Understanding the habitat ecology and interactions of coexisting mammals is crucial to adopt adequate conservation strategies for species vulnerable to habitat modifications (e.g. habitat specialists). European pine marten (*Martes martes*) and stone marten (*Martes foina*) are congeneric mustelids, similar in size, morphology and ecological traits. These species are sympatric in large part of their geographic range. However, the pine marten has been mostly described as a forest-dependent specialist of late-successional forests, while stone martens are present both in natural and human-altered landscapes. Differential habitat use and spatio-temporal interactions of pine and stone martens are poorly investigated in Italy, especially in Southern regions.
Here we used 66 pine marten and 150 stone marten detections from 76 white-flash cameras (4345 camera days in total) deployed in a protected area of Southern peninsula, to evaluate habitat use and potential for competition of the two marten species. White-flash images enabled a reliable species identification. We used 12 7-days occasions in single and two species occupancy models to investigating spatial co-occurrence of stone and pine martens while taking into account habitat variables. A Kernel Density Estimators approach has been applied to examine activity patterns.
Diel activity patterns of pine and stone martens overlapped during autumn-winter season (Coefficient of overlap $\Delta = 0.86$). During spring-summer the activity overlap decreased ($\Delta = 0.68$) and the two mustelids exhibited different activity patterns (Wald test $W = 3.44$, $p < 0.10$) with pine martens showing more diurnal activity. Single species modeling supported the view of *Martes martes* as a forest carnivore. The proportion of old-growth forests was the best predictor ($\beta = 0.77 \pm 0.37$ SE, $p<0.05$) of pine marten occupancy. The habitat edge was the best predictor of occupancy probability for stone martens ($\beta = 0.86 \pm 0.43$ SE, $p<0.05$), suggesting the use of more fragmented habitats. We found evidence that the pine marten occupancy was affected by the presence of stone marten. The probability of pine marten occupancy was higher when stone martens were absent (0.749 ± 0.173 SE) than when they were present (0.245 ± 0.091 SE), and increased with the proportion of forests. The species interaction factor was estimated to be 0.565 ± 0.168 SE ($p < 0.05$), indicating spatial avoidance by the pine marten.
Our findings provide the first evidence of spatial and temporal segregation between co-existing stone and pine martens.

Quantifying migratory bat movements across seasons and years using acoustics and a Vertical-Looking Radar

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Bat migration is an ecologically important yet poorly understood process, largely due to bats' nocturnal behaviour and frequent high-altitude flights, which hinder effective monitoring. In Europe, several bat species undertake long-distance seasonal migrations, and understanding their phenology is crucial for conservation, particularly under global environmental change, climate variability, and increasing anthropogenic pressures such as wind energy development. However, long-term quantitative information on the timing and intensity of migratory bat movements remains scarce.

We used a vertical-looking radar to quantify and characterise multi-annual migratory bat phenology on the Swabian Alb plateau (Germany) from September 2019 to December 2022. Radar data were filtered to retain only echoes classified as bats and converted into nightly bat traffic rates (bats·km^{-1}·night^{-1}). Migratory periods were identified based on seasonal patterns in abundance and abrupt shifts in flight directions detected through changepoint analysis. Radar-derived phenology was compared with simultaneously collected acoustic data from detectors mounted at high elevation to reduce contamination from local foraging flights.

Radar-derived bat activity showed a consistent seasonal pattern across years, with minimal activity in winter (December–February), a gradual increase from March onwards, and a pronounced peak in summer, followed by a progressive decline in autumn. Pre-maternity migration began between late February and mid-March and ended in mid–late May, while post-maternity migration started between July and early August and extended until late October or mid-November.

Peak nightly bat traffic ranged from 1159 to 2473 bats·km^{-1}·night^{-1}, with the highest value recorded on 4 July 2022. Both timing and magnitude of peak activity varied markedly among years, with shifts in migratory timing exceeding 20 days. Seasonal totals showed strong interannual variability, with pre-maternity migration accounting for approximately 1400–2500 bats·km^{-1} and post-maternity migration for about 6800 to over 12000 bats·km^{-1}. Radar- and acoustics-derived nightly bat numbers were positively correlated during pre- and post-maternity migration (Pearson's r = 0.14–0.71), although radar consistently detected substantially higher numbers.

Our results demonstrate that vertical-looking radar is a powerful tool for quantifying seasonal variability and interannual shifts in high-altitude bat migration, capturing movements that are only partially detected by acoustic monitoring. The observed interannual variability in migration timing and intensity suggests that bat migration is sensitive to changing environmental conditions, including year-to-year variation in weather. By enabling long-term, large-scale assessments of migratory bat phenology, radar-based approaches can substantially improve our understanding of bat ecology in a changing world and provide critical information to support conservation planning, including the mitigation of impacts from expanding wind energy infrastructure.

People and wildlife: Ungulates' responses to humans' presence and activities across Europe

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Across Europe, wildlife populations persist in landscapes deeply shaped by centuries of human activities that led to habitat loss and modification. While the impact of these changes has been widely explored, the ecological consequences of widespread human use of natural areas for recreation and outdoor activities remain poorly understood. The pervasive presence of human disturbance might led to changes in animal behavior and threaten wild species persistence even in areas, such as Europe, where conservation policies mitigate many traditional threats. Using camera-trap data contributed by multiple collaborators and several European monitoring networks and initiatives, including Snapshot Europe, Euromammals/EuroCAM, Big_Picture, and the European Observatory of Wildlife, we assessed how human presence and activity influence ungulates' occurrence and diel activity across gradients of anthropization and at different spatial and temporal scales.

We quantified species responses to human presence using multi-species occupancy models that explicitly account for imperfect detection while exploring drivers of species co-occurrence. These models incorporated environmental covariates and multiple dimensions of human activity, from camera- to landscape-level proxies of disturbance, allowing us to evaluate the direction, strength, and intensity of responses across different spatio-temporal scales. We also examined human-driven shifts in diel activity using hierarchical models designed to capture temporal patterns while accounting for site-level variability and sampling effort. Finally, we explored whether specific traits were associated with patterns of response to human disturbance.

Our results show that human presence is associated with reduced occupancy for a subset of species, with responses varying along gradients of human activities. We detected consistent shifts in activity timing for several taxa, suggesting behavioral adjustments to avoid human disturbance. Trait-based analyses indicate that larger-bodied species and those with specific dietary strategies are disproportionately affected.

Together, these findings demonstrate that human activity can reshape both space use and temporal behavior of wildlife across different landscapes, even in regions with robust conservation frameworks. By leveraging data from several European camera trap networks and collaborators, this study highlights how collaborative efforts can help shed light on ecological patterns across large scales, providing insights for managing human access and mitigating disturbance in areas critical for wildlife persistence.

Sharing space, avoiding time: how *Martes* coexist with humans and domestic cats

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Understanding how small carnivores persist in landscapes increasingly influenced by humans is central to their conservation and management. Across Europe, the expansion of human activities and the presence of domestic animals are requiring species to adapt their spatial use and temporal behaviour. Large-scale coordinated monitoring initiatives, such as the Snapshot Europe initiative, provide a unique opportunity to investigate coexistence mechanisms across diverse ecological contexts.
We investigated spatial co-occurrence and temporal overlap in activity patterns of *Martes* spp., humans, and domestic cats *Felis catus* using camera-trap data collected across 12 study areas monitored over two consecutive years in 11 European countries within the Snapshot Europe survey during 2021–2022. We analysed detection/non-detection data using multi-species occupancy models to estimate species-specific occupancy and pairwise co-occurrence while accounting for imperfect detection. Temporal activity patterns were modelled using trigonometric hierarchical models to quantify diel partitioning among species while accounting for sampling effort and site-to-site variability. We also assessed whether species-specific detection rates were negatively associated with anthropogenic pressure, quantified as the value of Human Footprint Index (HFP-100) averaged within 500 m buffers around camera locations.
Multi-species occupancy models showed no evidence of spatial avoidance between *Martes* spp. and either humans or domestic cats. Estimated occupancy probabilities, averaged across the study areas, were moderate for *Martes* spp. ($\psi \approx 0.41$+/-0.14) and domestic cats ($\psi \approx 0.35$+/-0.11), and high for humans ($\psi \approx 0.82$+/-0.10). Pairwise co-occurrence estimates between *Martes* spp. and both humans and domestic cats were usually moderate (0.59+/-0.11 and 0.55+/-0.12, respectively), suggesting a certain level of spatial independence. Across study areas, detection rates of *Martes* spp. were not associated with the HFP-100 ($\beta \approx 0.001$, $p = 0.98$), indicating stable spatial use intensity across the anthropogenic gradient. In contrast, activity pattern analyses revealed marked temporal segregation between *Martes* spp. and humans, with *Martes* detections being predominantly nocturnal (86% of records at night) and human detections largely diurnal (96% during daytime). Hierarchical activity models further supported moderate temporal shifts in *Martes* activity on days with human presence. *Martes* spp. and domestic cats exhibited substantial overlap in nocturnal activity and showed no evidence of temporal partitioning.
This work generalises previous findings from Elba Island, confirming that temporal segregation represents a general and repeatable mechanism facilitating the coexistence of *Martes* spp. with humans across different European landscapes. While *Martes* spp. tolerate spatial overlap with both humans and domestic cats, temporal segregation, particularly in response to human activity, appears to be a key behavioural strategy facilitating persistence. This analysis also confirms strong spatial and temporal overlap between *Martes* spp.and domestic cats; this finding calls for focused exploration of the relationship between these mesocarnivores. Our findings highlight the importance of integrating spatial and temporal dimensions to understand carnivore persistence in increasingly anthropogenic environments.

Genetic structure of the largest terrestrial wild animal in Italy, the red deer Cervus elaphus: potential effects of isolation, human-mediated movements and hybridisation with non-native species

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The red deer *Cervus elaphus* is the largest wild terrestrial vertebrate in Italy, and its present-day genetic structure reflects a complex interplay between Late Pleistocene climatic refugia and extensive human-mediated translocations aimed at restocking populations depleted by overhunting. Despite its ecological and management importance, the species has never been investigated at a nationwide genetic scale in Italy. Here, we present the first comprehensive assessment of the genetic diversity and population structure of Italian red deer and evaluate the impact of biological invasions through hybridization with the invasive sika deer *Cervus nippon*. The sika deer is currently listed among invasive alien species of Union concern under EU Regulation 1143/2014, thus requiring strict monitoring and, where feasible, eradication.
We performed mtDNA D-loop and single nucleotide polymorphisms (SNPs) analyses across Italian regions. Italian red deer populations exhibited pronounced genetic structuring, with 38 haplotypes assigned to the three main European haplogroup lineages (A, C, and D). Haplogroup B, represented in Italy by the Sardinian subspecies *C. e. corsicanus*, was not included in this study. Haplogroups A and C co-occurred in several regions, providing strong evidence that historical translocations have shaped the current genetic landscape. Haplogroup D was restricted to the "Bosco della Mesola" Reserve, with the Italian endemic subspecies *C. e. italicus*, and to a small area in southern Tuscany, where free-ranging individuals originating from an enclosure occur. Our analyses did not detect any wapiti *Cervus canadensis*, which were introduced to La Mandria Regional Park (Piedmont) in the nineteenth century. Seven samples from the northern Apennines (Liguria, Tuscany, and Emilia-Romagna) were assigned to the invasive sika deer.
In addition, 35958 SNPs were obtained for the species, allowing us to update the distribution of sika deer in Italy, where the species has been present for at least 25 years but has never been formally assessed. SNP analyses revealed some sika deer introgression in red deer populations in central Italy, confirming ongoing hybridization processes. Our results reveal a nuanced picture of red deer population structure in areas where reintroductions have occurred, while identifying regions where genetic diversity remains at risk due to sika deer releases.
Overall, our results show that the genetic structure of *C. elaphus* in Italy reflects the combined effects of historical biogeographic processes and long-term human influence, while highlighting the urgent need for genetically informed management strategies to preserve native lineages (particularly the Italian red deer and the Sardinian red deer), and mitigate the impacts of invasive-driven hybridization. Given the likely continued range expansion of both invasive sika deer and red × sika hybrids, further hybridization poses a serious threat to the genetic integrity of native red deer populations. Our findings highlight the need to conserve the genetic diversity of *C. elaphus* by preserving its distinct evolutionary lineages and implementing management strategies aimed at limiting invasion-driven genetic pollution.

Vulnerability of mammals to bushmeat hunting

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Bushmeat hunting is a widespread threat to terrestrial mammal populations, yet species differ considerably in their susceptibility to exploitation. Identifying the biological traits associated with hunting vulnerability is essential for anticipating impacts and informing conservation prioritisation. In this study, we assess how ecological, behavioural and life-history traits influence the probability that mammal species are targeted for bushmeat. Species-level information on hunting pressure was compiled from the IUCN Red List by integrating structured threat classifications with qualitative species accounts. Based on documented evidence, species were classified according to the presence or absence of bushmeat hunting, while cases of uncertainty were excluded. This approach allowed the construction of a comparative dataset distinguishing hunted and non-hunted terrestrial mammal species. We used a trait-based generalized linear mixed model to evaluate which species characteristics are associated with vulnerability to bushmeat hunting, while accounting for geographical and evolutionary relatedness among species. Predictor variables included activity pattern, body size, diet, foraging behaviour, habitat and altitudinal breadth, and reproductive traits. We used the results of this model to predict which species currently not hunted for bushmeat could become so based on their intrinsic characteristics (probability above 50%). Our analyses indicate that vulnerability to bushmeat hunting is non-random and strongly structured by species traits. Traits related to accessibility and detectability, such as activity cycle and foraging stratum, as well as life-history characteristics linked to population recovery, emerged as important predictors of hunting susceptibility. We also found that 261 species for which there is currently no evidence of bushmeat hunting could become hunted based on their traits. By identifying species potentially vulnerable to future exploitation, this framework can support early-warning strategies and inform targeted conservation actions in regions under increasing hunting pressure.

From The Woodland To The City: Genome-Wide Comparison Of Rural And Urban Red Squirrel Populations In Northern Italy

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Cities present unique and dynamic challenges for resident wildlife. While exposing them to novel dangers, urban habitats offer sources of shelter, warmer conditions, highly stable and different food sources, and improved foraging conditions. In response to anthropogenic pressures, urban wildlife may show different traits than their non-urban counterparts. The Eurasian red squirrel (Sciurus vulgaris) had a widespread presence in the Italian peninsula. However, present day populations face significant challenges due to habitat loss and the disastrous impact of introduced species. This small mammal is able to adapt to urban habitats and to take advantage of living alongside humans. The behavioural modifications observed in urban-dwelling individuals may imply a genetic predisposition or adaptive genetic changes, an aspect that has not been investigated so far. This study aims to investigate whether red squirrel urban populations show a different genetic make-up and signatures of selection at genes influencing traits that can play a role in adaptation to life in the city.
Squirrels were live-trapped along a gradient of urbanization, with ear-punch samples and biometric data collected from each individual. Whole genome sequencing of 89 samples was carried out with a 5x coverage, with reads aligned to the species' reference genome (mSciVul1.2). Variant calling yielded 2,539,650 SNPs after filtering in PLINK 2.0. Population structure was described by individual ancestry analysis and PCA; genomic diversity, runs of homozygosity (ROH) and outlier analyses were performed using VCFtools, BCFtools, dartR, and RAiSD, while gene ontology (GO) and gene enrichment analyses were carried out using ShinyGO and Enrichr.
Both rural and urban populations showed a relatively heterogenous structure, consistent with varying contributions from multiple ancestral sources. They resulted similar in overall heterozygosity (rural: Ho= 0.16, He= 0.26; urban: Ho= 0.18, He= 0.25), distribution of short (<300Kb) runs of homozygosity and coefficient of inbreeding (rural FROH=0.27, urban FROH=0.22); yet, urban red squirrels showed longer ROHs, suggesting recent founding events in urban populations. We retained the top 1% regions resulting from the outlier analysis (FST and pi-ratio, 50Kb sliding windows), possibly indicative of selection. By gene enrichment analysis, genes mapping in these regions were associated to biological processes such as regulation of cardiac functions, regulation of actin filament-based movement, glycerolipids and glycerophospholipids metabolism, that can potentially be associated with exposure to stress in urban environments.
Our results identify differences between urban and rural populations, with urban populations presenting genes possibly involved in adaptation to anthropized environments. In the context of rapid urbanization and increasing anthropogenic pressure, understanding how urban mammalian wildlife is able to adapt is essential to inform conservation and management efforts. This study highlights the importance of integrating population genomics information into the body of knowledge on urban mammal biodiversity. This work was supported by the Italian Ministry of University and Research (Project of Relevant National Interest 2022 - grant number 2022N9CSKJ).

Species traits mediate mammal density responses to human impacts

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Human activities are reshaping ecosystems, but their effects on species population density - a key component of biodiversity - remain poorly understood. Most studies focus on species presence-absence data, thus limiting insight into how anthropogenic pressures affect species' population abundance. Emerging evidence suggests that responses of natural populations to human disturbance are highly variable, often contingent on species-specific traits. Here, we test how species traits mediate the density responses of mammal populations to different forms of human impact.

We quantified the correlations between mammalian population densities and urban cover, cropland cover, and human population abundance, using 7,785 population density estimates across 263 species belonging to 18 taxonomic orders. Using Bayesian inference, we then conducted three correlation meta-analyses, and subsequently tested the effect of body mass, diet and life history traits, and taxonomic group, on the correlations using meta-regression models.

We found no overall directional effect in mammal population density with increasing urban cover, but we found positive effects of increasing cropland cover and human population abundance. Responses to impact gradients deviated from these overall effects depending on species' traits. For example, herbivores exhibit lower densities in urban and human-dominated landscapes, whereas omnivores and large-bodied species show higher densities. Frugivores displayed lower densities in agricultural landscapes.

Our results suggest that anthropogenic landscapes, where natural habitat is interspersed with anthropogenic land use and human settlements, can support high overall population abundance, but alter species relative abundance by favouring some species over others. This study underscores the complexity of human–nature interactions and the importance of species traits in mediating ecological outcomes.

Bats of Rome: how urban landscape shape species' distributions

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Bats are an important component of urban wildlife, with many species capable of exploiting anthropogenic structures. Nevertheless, urbanization can threaten habitat specialists, limiting their presence and distribution. In a world where urbanization is projected to increase, it is pivotal to properly manage the cities to promote habitat heterogeneity and mitigate biodiversity loss.
To investigate how bat assemblages, activity and diversity vary in different conditions, we carried out an intensive data collection within the metropolitan area of Rome (Italy), deploying automatic acoustic devices both within and outside green spaces. From the recordings, we extracted presence, activity and richness for eleven bat species (four of them being notoriously synanthropic) overall representing 32% of all Italian bats and 20% of European bats. We modelled occupancy, activity and richness levels to explore the influence of anthropic and natural factors on bat presence. Finally, we used the models to predict these values over the whole cities and generate maps.
We found a wide range of responses in different species: synanthropic species are more active in presence of artificial light while other bats can be influenced by edge density, landscape diversity or distance from the city centre. Two responses are consistent: a positive effect of water and a negative effect of big roads, also confirmed by the richness model.
These findings highlight the importance of considering the differences between species while making decisions regarding urban planning and wildlife management inside cities since different adaptations can lead to different sensibilities to the urban environment. At the same time, if we want to preserve bats inside cities, we can not ignore the universal importance of water to sustain their populations in this difficult environment and the threat posed by big roads that represent a source of disturbance as well as a resource-poor surface. We hope our findings, together with our maps, could help future planning to improve the conservation of bats in cities.

Phylogeography and population structure of the Western European hedgehog (*Erinaceus europaeus* Linnaeus,1758) across Italian islands and mainland

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The Western European hedgehog (*Erinaceus europaeus*) represents a valuable model for investigating post-glacial recolonization dynamics and the long-term effects of geographic isolation on the genetic structure of small mammals. Despite its wide distribution across Europe, the genetic characterization of Italian populations remains incomplete, limiting our understanding of how past climatic oscillations have shaped their population dynamics. Investigating patterns of genetic diversity across a geographically representative sample can therefore provide key insights into their evolutionary potential, with important implications for conservation strategies, particularly under ongoing global change.

Here, we provide a comprehensive assessment of the genetic diversity and phylogeographic structure of *E. europaeus* across the Italian peninsula and five Mediterranean islands (Sicily, Sardinia, Corsica, Elba, and Pianosa). Using 19 nuclear microsatellites and mitochondrial control region sequences from 210 individuals, we identified seven distinct genetic clusters shaped by a complex interplay of historical, geographic, and anthropogenic factors.

Peninsular populations showed a relatively homogeneous clinal structure consistent with post-glacial recolonization from southern Mediterranean refugia, with subtle differentiation in northeastern Italy. In contrast, the Sicilian population emerged as a deeply divergent and ancient lineage, likely reflecting long-term isolation and an independent evolutionary trajectory, supporting its recognition as an Evolutionarily Significant Unit (ESU). Conversely, Sardinian and Corsican populations exhibited genetic signatures consistent with more recent, human-mediated colonization, while the small island populations of Elba and Pianosa showed pronounced genetic erosion and evidence of translocations.

Our results highlight Mediterranean islands as critical reservoirs of unique genetic diversity but also as systems particularly vulnerable to genetic impoverishment under demographic instability. In the context of accelerating climate change, habitat fragmentation, and increasing anthropogenic pressure, the preservation of distinct genetic lineages and ESUs is essential to maintain adaptive potential and long-term population resilience. This study underscores the importance of integrating phylogeographic and population genetic information into conservation strategies aimed at safeguarding mammalian biodiversity in rapidly changing environments.

Outcome monitoring of water vole reintroductions in ecological restoration

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Growing awareness socially, economically, and politically, of extensive biodiversity loss in the UK is motivating a wide range of ecological restoration targets and projects. These range from targets for tree cover on farmland for environmental schemes to rewilding. Water voles (*Arvicola amphibius*) in the UK disappeared from 90% of their known range between 1970-2000. Their decline was driven by the introduction of the American mink (*Neovison vison*), and land use changes, where intensive livestock and dairy production has encroached on riverbank habitat. The restoration of their riparian habitat has included restricting livestock access, and removing the invasive American mink, permitting the reintroduction of captive bred water voles in over 250 sites across the UK since 2003. However, despite this conservation campaign, outcome monitoring of water vole reintroductions is limited, particularly in terms of health and survival rates. Our aim was to fill some of the gaps in post- reintroduction monitoring of water voles, develop a tool for post-release monitoring, and assess the potential of reintroduced species as sentinels of ecosystem health. Given that gut microbiota plays a vital role in host health, influencing immunity and physiology, identifying hypothesised post- reintroduction shifts is therefore important for animal welfare and reintroduction success.
We collected faecal and water samples concurrently from two water vole populations: one reintroduced in 2024 and one established in 2014. Samples were collected systematically for three months following the release of the newly reintroduced population. Whole DNA was extracted from each sample and the 16S rRNA gene (V3-4) and ITS2 region were amplified for Illumina amplicon sequencing. Bioinformatic analyses included the estimation and comparison of alpha and beta diversities between populations and over time, temporal changes in bacterial taxa relative abundance, source tracking to assess environmental microbiota influence on water vole microbiota, and inference of the functional roles of taxa associated with post-reintroduction microbial acquisition. The newly reintroduced water vole population showed higher alpha diversity (Shannon index) overall than the established population, with no significant temporal changes observed in either population. Beta diversity (Bray Curtis dissimilarity) in the established population remained stable over time, whereas the reintroduced population experienced an initial rapid shift in community composition during the first two weeks post-release, stabilizing by week five. Temporal beta diversity analysis revealed that the microbiota of the reintroduced population initially converged rapidly towards that of the established population, followed by a relatively stable phase with small fluctuations. We will also discuss the results of source tracking (the influence of environmental microbiota on that of the water voles), and temporal analyses of the microbial community composition at a taxonomic level, including potential pathogens. We conclude that reintroduced water voles experienced a rapid and substantial shift in gut microbiota composition shortly after release, changes not seen in the established population. This highlights the significant impact of reintroduction and adaptation on gut microbial communities and provides a novel timescale for these changes.
Our results provide insight into the impact of reintroduction of a captive bred population using a structured comparative study design. Better understanding of gut microbial community composition, sources of acquisition, and predicted functional impacts, will enable advancement and better leverage of microbiota-informed conservation practices.

SESSIONE 2.

Strategie comportamentali nei mammiferi: adattamenti evolutivi alle pressioni ambientali

Am I on the right track? Leisler's bats movements are shaped by both natural and anthropogenic landscape elements

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Woodlands constitute essential habitats to forest-dwelling bats, including migratory *Nyctalus* spp., yet their functional relevance in increasingly modified landscapes remains insufficiently explored. Although *Nyctalus* bats undertake long-distance seasonal movements even across heterogeneous landscapes, the behavioral mechanisms shaping movements, particularly how individuals adjust roosting and commuting decisions in fragmented environments, is still poorly understood e.g., no data on migration routes of bats in the Italian Peninsula is available to date.

To fill this gap and assess the role of landscape features in shaping bat long-distance movements, we deployed lightweight Sigfox tags on *N. leisleri* roosting in the Apennine forests in central Italy. Sigfox tags are low-cost ultra-low-power devices which exploit the Internet of Things (IoT) network, remotely recording location data and thus providing a reconstruction of individual movements without the need to retrieve the device. We then assessed the land use composition at commuting and roosting sites identified by tracking, as well as exposure of individual routes to wind farm plants.

We obtained tracking data from 13 individual bats recording both short commuting and long-distance migratory movements of up to 150 km from tagging location. Records indicated that individuals first commuted repeatedly from core roosting sites to small forest remnants within urban and peri-urban matrices. Long-distance migratory movements instead indicated a key role of remnant wooded riparian strips. Most roosting locations during migration occurred within or immediately adjacent to riparian habitats containing natural vegetation remnants, and woodland fragments on the margins of largely anthropic areas. Approximately 25% of the tracked individual routes passed through wind farm plants or in their immediate proximity, highlighting the great risk posed by these structures to migratory bats.

These findings indicate that *N. leisleri* responds to fragmented resource distributions through substantially adaptive behavior, actively selecting profitable habitat remnants. Integrating individual-based tracking data into conservation planning can identify overlooked ecological connections, refine assessments of collision risk at wind farms, and guide evidence-based mitigation strategies. We argue that retaining structurally complex forest remnants within urban and riparian green networks, alongside expanded long-term tagging efforts, will be essential to anticipate and mitigate ecological responses of forest bats to accelerating habitat fragmentation and renewable energy expansion.

Caught in the crossfire: sex-specific responses of Alpine chamois to heat stress and predator return

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The decline in key demographic parameters of Alpine chamois over recent decades has raised major conservation concern. Climate warming is widely implicated, with increasing spring–summer temperatures linked to reduced body mass and survival in younger age classes. Wolf recolonization across the Alps adds a further pressure whose direct and indirect consequences for chamois behaviour and fitness remain incompletely understood. Because females and males differ in life-history tactics and ecological priorities, they may also differ in how they trade off forage acquisition, thermal conditions, and predation risk when adjusting to these emerging pressures.

We investigated sex-specific strategies and habitat selection in 27 GPS-collared adult chamois (15 males, 12 females) monitored from 2023 to 2025 in the Italian Prealps. We quantified seasonal changes in individual body mass using repeated measurements from automated weighing platforms. We modelled sex-specific habitat selection with resource selection functions that captured seasonal variation in selection for habitat type and wolf predation risk and, during foraging, for local pasture quality and air temperature. Thermal conditions were characterized using ground-based temperature loggers deployed across elevations and habitats, and were used to develop a habitat- and topography- informed model predicting air temperatures experienced by animals. Spatial variation in wolf predation risk was derived from local wolf GPS telemetry and kill-site surveys, yielding a landscape- scale representation of predation risk. Pasture quality was indexed using satellite-derived vegetation metrics. Females and males showed contrasting seasonal strategies in space use, consistent with divergent spring–autumn body-mass trajectories, with males increasing body mass and females remaining stable or declining. Females consistently selected lower-risk areas year-round and increased selection for cooler habitats during the warmest months. This thermoregulatory pattern was also evident during foraging, with females shifting from selection of warmer meadow locations in winter–spring to cooler meadow locations in summer. Males showed only weak selection for lower-risk areas outside winter and exhibited limited thermal avoidance during summer despite pronounced thermal contrasts among habitats. During foraging, both sexes selected higher-quality pastures when overall forage quality was low (autumn–spring). In summer, males showed broadly similar selection across the pasture-quality gradient, whereas females shifted toward lower-quality patches, consistent with stronger constraints from thermal balance or risk avoidance during this period. Together, these results indicate pronounced sex-specific trade-offs in how chamois respond to warming temperatures and wolf recolonization. Female strategies emphasize thermal balance and risk avoidance but entail indirect costs through reduced access to high-quality forage, with potential downstream consequences for offspring performance. Male strategies emphasize forage acquisition, with comparatively greater exposure to thermal and predation constraints. These findings underscore the value of integrating sex-specific habitat selection into monitoring and management frameworks in systems experiencing concurrent climatic and predator-driven change.

Ecological, social and anthropogenic drivers of wolf feeding ecology in Italy

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Understanding the factors influencing wolf (Canis lupus) feeding ecology is essential for assessing their ecological role in human-modified landscapes. In Southern Europe, wolves inhabit highly heterogeneous environments characterized by variable prey communities, anthropogenic food sources, and different levels of human pressure. These conditions may influence the balance between predation, scavenging, and carcass reuse, but the mechanisms driving this variability are still poorly understood.
Between 2020 and 2025, we GPS-tracked 19 wolves across five study areas in Italy and monitored their feeding strategies using a standardized cluster-checking protocol. This approach enabled detection of feeding events and their classification into four feeding strategies: wild prey predation, livestock predation, scavenging, and carcass reuse. We defined predation as the killing and consumption of wild or domestic prey, carcass reuse as the consumption of prey previously killed by the same individual or pack, and scavenging as the consumption of resources not killed by wolves. Using 1254 confirmed feeding events, we modelled the daily probability of each feeding strategy. We investigated the role of ecological, social, and anthropogenic variables, including local availability of wild vs domestic prey (biomass/km2), main wild prey species, pack size, individual social status, and human-footprint.
Our results showed that predation on wild prey was negatively associated with domestic prey biomass, with wolves increasingly preying on wild ungulates where domestic resources are limited. Livestock predation showed strong seasonal patterns, increasing during summer grazing periods, and was more frequent where main wild prey species were relatively small (e.g., roe deer). Carcass reuse was influenced by pack size and prey body mass, being highest when large prey were exploited by smaller packs. It was also more frequent in non-breeding individuals, likely reflecting energetic constraints, as subordinate wolves may have reduced priority access to fresh kills and may rely more on low-cost feeding opportunities such as returning to existing carcasses. Scavenging increased during winter and under low wild prey biomass, suggesting a shift towards alternative feeding strategies under resource-poor conditions, and was more frequent in non-breeding individuals, consistent with the use of low-cost survival strategies.
This interplay of environmental and demographic drivers highlights the remarkable plasticity of wolf feeding ecology. Because feeding behaviour underpins both wolves' ecological effects and the potential for conflict with human activities, these findings provide an essential basis for long-term conservation and management across gradients from natural to highly human-dominated landscapes.

Predators in the night, prey in the light: ecology, evolution and implications of temporal mismatch in predator-prey interactions among large terrestrial mammals

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Time is a core, yet often undervalued, ecological dimension structuring predator-prey interactions worldwide. In large terrestrial mammals, a growing wealth of empirical evidence documents frequent temporal mismatches in daily activity rhythms between predator and prey across diverse taxonomic, ecological and geographical contexts. Nevertheless, such mismatches are commonly interpreted as maladaptive, based on the underlying assumption that temporal overlap is equivalent to increased predation success. Here, we challenge this axiom by reframing predator-prey temporal mismatch in large terrestrial mammals as a recurrent and potentially functional outcome of shared evolutionary histories, physiological and sensory constraints, and current predator-prey mechanisms.
We conducted an extensive interdisciplinary review of theoretical and empirical studies addressing activity rhythms and temporal interactions in large terrestrial mammals, focusing on temporal mismatch in predator-prey systems involving large carnivores and ungulates.
The literature was analysed across six complementary dimensions: (i) evolutionary origins of temporal mismatch and long-term temporal niche conservatism, (ii) physiological and sensory constraints on activity timing,
(iii) environmental drivers modulating daily activity rhythms, (iv) predator-prey interaction mechanisms ranging from temporal synchronization to segregation, (v) anthropogenic factors affecting temporal behaviour, and (vi) socio-ecological implications and opportunities for mammal conservation and human-wildlife coexistence. Studies were compared across taxa, ecosystems and gradients of human disturbance to identify recurring patterns and principles underlying temporal mismatch.
Overall, temporal mismatch in predator-prey interactions among large terrestrial mammals emerges as a widespread and persistent pattern rather than an anomaly. Evidence indicates that temporal mismatch is rooted in conserved coevolutionary histories, nowadays still corroborated by taxon - specific physiological and sensory constraints. Predator-prey interactions dynamically unfold along a continuum between temporal synchronization and segregation. Temporal refuges oftentimes represent an effective antipredator strategy, potentially promoting temporal mismatch, without undermining opportunities for predation. Environmental drivers, such as weather conditions and moonlight, frequently modulate these dynamics, whereas anthropogenic pressures, including artificial light at night, noise, infrastructure, as well as lethal and non-lethal activities, increasingly impose forced temporal shifts, often disrupting temporal balance beyond historically adaptive ranges.
Our work suggests that temporal mismatch in predator-prey interactions among large terrestrial mammals is not inherently maladaptive. Conversely, it may act as a functional mechanism contributing to the persistence of predator-prey systems. Nonetheless, ongoing anthropogenic changes may transform historically adaptive temporal relationships into temporal ecological traps. Recognising time as a fundamental ecological axis can strengthen our understanding of predator -prey dynamics, and may open new frontiers for developing more comprehensive, effective and socially sustainable strategies for mammal conservation and management, ultimately enhancing human- wildlife coexistence.

First insight into temporal activity patterns of three sympatric *Pipistrellus* species in a Mediterranean coastal forest ecosystem

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Temporal activity patterns in bats emerge from the interplay between abiotic factors and interspecific interactions, yet how these drivers jointly affect species sharing the same habitat remains largely unexplored. Here, we analyzed nocturnal activity patterns of three Pipistrellus species (*Pipistrellus pipistrellus*, *P. pygmaeus* and *P. kuhlii*) living in syntopy in a Mediterranean coastal woodland in central Italy to investigate the factors influencing their foraging activity and temporal overlap.

We collected passive acoustic data in June-July 2024 within the Tenuta Presidenziale di Castel Porziano (central Italy) using Song Meter Mini Bat recorders. To ensure spatial representativeness, the area was divided into 600 × 600 m grid cells and 40 cells were randomly selected. Recorders were deployed near the center of each selected cell and operated for 3-4 consecutive nights, resulting in 1260 hours of monitoring. Bat calls were processed and manually validated using Kaleidoscope software. We described species-specific activity curves using LOESS smoothing, quantified pairwise temporal overlap using kernel density estimation and the overlap coefficient (Δ), and modelled hourly acoustic activity through Generalized Linear Mixed Models (GLMMs). Models included mean hourly air temperature, moon brightness, and the simultaneous activity of the other two *Pipistrellus* species as fixed effects, while sampling site and date were included as random intercepts.

A total of 38,993 *Pipistrellus* call sequences were detected, with *P. kuhlii* accounting for 79.6% of the total calls, followed by *P. pygmaeus* (14.6%) and *P. pipistrellus* (5.8%). The three species displayed distinct nocturnal activity patterns and variable degrees of temporal overlap. *Pipistrellus pipistrellus* showed a unimodal pattern with a pronounced peak early in the night (22:00–23:00) followed by a progressive decline, whereas *P. pygmaeus* exhibited a bimodal and strongly crepuscular profile, with two peaks at sunset and before sunrise. *Pipistrellus kuhlii* showed high activity throughout the night, with a strong peak around 23:00 and a gradual decline until the early morning hours. Temporal overlap analyses revealed extensive overlap between *P. kuhlii* and *P. pipistrellus* (Δ = 0.74), intermediate overlap between *P. kuhlii* and *P. pygmaeus* (Δ = 0.66), and the lowest overlap between *P. pipistrellus* and *P. pygmaeus* (Δ = 0.58). Increasing temperature was positively associated with *P. kuhlii* activity, while no significant temperature effect was detected for *P. pipistrellus* and *P. pygmaeus*. Moon brightness was negatively correlated with *P. kuhlii* activity, a pattern not previously reported for European *Pipistrellus* species. Finally, activity was generally positively associated among co-occurring species, suggesting shared responses to environmental conditions rather than strong temporal exclusion.

Consistent with theoretical expectations on niche partitioning, the more generalist species, *P. pipistrellus*, slightly modified its expected temporal profile, whereas the more specialized species, *P. pygmaeus*, maintained a strongly crepuscular bimodal activity pattern. This suggests that behavioural flexibility in foraging time may contribute to coexistence within syntopic bat assemblages. The strong negative association between moon brightness and *P. kuhlii* activity contrasts with the species' tolerance to artificial light, indicating that responses to natural illumination may differ and deserve further investigation. Overall, our findings highlight the combined influence of environmental conditions and interspecific associations on fine-scale temporal activity patterns, confirming the value of passive acoustic monitoring to investigate behavioural partitioning and coexistence mechanisms in bat communities.

Summer tourism reshapes activity patterns and roadkill risk in alpine small carnivores

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Recreational non-consumptive activities can significantly affect wildlife by influencing behavior, reshaping ecological interactions, and increasing mortality risk. However, studies highlighting these impacts remain scarce, particularly in mountain environments. In this study, we investigated the effects of summer tourism on a community of alpine small carnivores: the least weasel (*Mustela nivalis*), the stoat (*Mustela erminea*), the pine marten (*Martes martes*), and the stone marten (*Martes foina*). Specifically, we compared diel activity patterns in competitive and predator–prey interactions, as well as variation in roadkill risk under two disturbance scenarios. From May to October 2024, we deployed baited trail cameras and unbaited Alpine Mostelas (i.e., an enclosed camera-trap system specifically developed for small mustelid monitoring) in the Alpi Marittime Natural Park, sampling 60 grid cells below and 60 above 1600 m a.s.l. respectively. We used daily vehicle and hiker counts to classify days as low- or high-impact, then quantified changes in temporal niche and calculated activity overlap coefficients between target species, their potential prey, and competitors under both disturbance scenarios. Lastly, we estimated roadkill risk for martens as the total number of vehicles potentially encountered by target populations.

While stone martens and stoats showed no significant shifts in activity patterns between low- and high-impact days, pine martens exhibited a marked temporal shift under high disturbance, concentrating their activity around sunrise. Under high-impact conditions, activity overlap between pine martens and both competitors and prey decreased substantially, especially with bank voles (from $\Delta_{LOW} = 0.706$ to $\Delta_{HIGH} = 0.508$) and with dormice (from $\Delta_{LOW} = 0.614$ to $\Delta_{HIGH} = 0.398$). Estimates of roadkill risk revealed a strong increase in potential vehicle encounters during high-impact days for both stone martens (+183%) and pine martens (+133%).

Among the target species, the pine marten showed the greatest behavioral flexibility. Its activity shift under the high-disturbance scenario reduced temporal overlap with humans and competitors but resulted in a pronounced mismatch with key prey species, suggesting suboptimal foraging conditions. Roadkill risk emerged as a relevant pressure for martens under both disturbance scenarios, with a marked increase during high-impact days. While pine martens experienced higher overall exposure to traffic, stone martens exhibited a greater relative increase in potential vehicle encounters under high-impact conditions, suggesting a limited ability to rapidly adjust to sudden increases in traffic intensity. Overall, these findings underscore the need for targeted mitigation measures and long-term monitoring programs, particularly in mountain landscapes exposed to high tourist pressure.

Anti-predator behaviours of fox squirrels change across urban green areas

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Urban ecosystems influence animal behaviour by acting as spatial filters that reduce optimal niches for some species, known as urban avoiders, while favoring conditions for others, referred to as urban exploiters. The fox squirrel (*Sciurus niger*) an invasive urban exploiter introduced in Idaho in 1918, has since colonized various urban habitats. Previous research indicates that urban squirrels normally exhibit reduced anti-predatory behaviors compared to rural populations, likely due to the prevalence of humans within urban boundaries. Yet, there is limited understanding of the role potentially exerted by urban green areas, and by environmental features potentially linked to these behavioral changes.
We analysed two key anti-predator behaviours in the field: the Alert Distance (AD, here defined as the distance at which an animal visually detects a threat), and the Flight Initiation Distance (FID, the distance at which an animal begins to flee when exposed to a threat). Namely, we examined these behaviours in fox squirrels across three green areas of a city, testing if and to which extent certain environmental characteristics of urban green spaces, including impervious surfaces, tree cover and human presence, were associated with AD and FID.
We found that ADs and FIDs measured across urban green areas were strongly associated with environmental features quantified in the immediate surroundings. Fox squirrels generally fled earlier when located farther away from a refuge and fled later in habitat patches highly visited by humans (β = -0.045, se $\pm$0.014, p = 0.001). In addition, we found a significant, negative relationship between AD/FID and impervious surfaces (β = -0.083, se $\pm$0.036, p = 0.022 and β = -0.004, se $\pm$0.002, p = 0.016), suggesting that animals spotted in greener areas appeared more vigilant than those observed in areas with extended impervious surfaces in the immediate surroundings.
Our results provide novel, and compelling evidence of anti-predator behavioural changes that go beyond the urban/non-urban dichotomy. Our findings revealed that distinct environmental features across green areas are strongly associated with AD and FID. To effectively predict the spread and success of invasive species like fox squirrels while colonizing human-modified landscapes, land managers, practitioners and stakeholders must consider the unique attributes of each habitat patch.

A complex relationship: behavioural interactions between wolves and wild boar

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The return of large carnivores to Europe is triggering complex ecological interactions, in which the non-lethal effects of predation and indirect interspecific interactions often play a central role. In the Maremma Regional Park (central Italy), the wolf *Canis lupus* has returned steadily since 2015. After an initial selection of fallow deer *Dama dama*, this predator has progressively shifted towards wild boar *Sus scrofa* as primary prey throughout the first 8 years since wolf settlement. Accordingly, a remarkable temporal and spatial association between the wolf and the wild boar was observed.

Despite the expectedly high predation rates, previous work found no evidence of marked antipredator responses based on spatial avoidance or a generalised reduction in nocturnal activity by wild boar. Intensive camera trapping suggested that temporal responses were more subtle than initially expected and depended on sex and age class. Analysis of nighttime brightness indicated that wolves exploited darker nights in areas more frequently used by their main prey. In turn, wild boar were more active during the brightest nights in the sites most used by the predator, suggesting that nocturnal light may modulate the perception of predation risk, particularly in a species characterised by relatively limited night vision due to physiological features. Moreover, analyses showed greater diurnal activity in females, especially females with piglets, compared to adult males, suggesting the development of sex- and age-specific antipredator strategies.

Beyond these temporal responses, we assessed support to the occurrence of an antipredator response based on increased gregariousness. We used six years of intensive camera trapping data (2017–2023) to evaluate the potential increase of wild boar group size throughout years, while evaluating also the potential role of confounding factors (i.e., wild boar density, acorn availability and dispersion, culling). We showed a progressive increase in the probability of observing groups and in the mean and maximum group size of wild boar groups with increasing years since wolf comeback. Conversely, no similar variations occurred in confounding factors, which showed no consistent relationships with wild boar group size. Hence, results support gregariousness as a central antipredator response for wild boar. Besides the potential advantages of dilution effects and collective vigilance, defence in groups would be expected to favour aggregation in a species with substantial body mass and potentially lethal weapons (i.e., tusks). Our findings emphasise the complexity of antipredator responses of wild boar, indicating that spatiotemporal avoidance could be more nuanced than previously expected. Considering the significant ecological role of both the wolf and the wild boar in temperate ecosystems, as well as their importance from management and conservation points of view, the analysis of long-term dynamics of their interactions is expected to bear important implication from fundamental and applied points of view.

The effects of urbanization on diel activity patterns of Italian mammals

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Urbanization represents one of the most pervasive forms of anthropogenic disturbance affecting wildlife behavior globally. Despite this, its effects on a key aspect of mammal ecology, i.e., their temporal behaviour, are still understudied, especially in Mediterranean urban contexts. Indeed, mammalian diel phenotypes (nocturnal, crepuscular, diurnal, and cathemeral) are increasingly recognized as plastic behavioral traits that can shift to mediate coexistence with humans.
This study represents a novel analytical framework to investigate diel activity of urban mammals, by integrating covariate effects and temporal availability in activity patterns analyses, overcoming the limitations of traditional kernel density estimation approaches. We specifically investigate diel temporal niche selection and diel activity patterns in medium and large size mammals using an extensive camera trap dataset collected across 59 sites in five Italian cities with varying urbanization levels. We employed Temporal Resource Selection Functions (TRSF) to assess selection for specific diel periods (day, night, twilight), and trigonometric models to detect fine-scale behavioral adjustments, i.e., shifts in peak activity times. These models incorporated ten environmental covariates, including land cover composition, imperviousness, tree cover density, and human population density. Variables were extracted at 1km and 2km buffers around camera trap locations. A total of 17,996 pictures and videos were recorded, documenting 12 wild mammal species.
Preliminary results on the red fox (*Vulpes vulpes*) revealed a strong nocturnal and crepuscular selection, with significant avoidance of the diurnal period. Notably, the species maintains temporal selection across the urbanization gradient, mirroring its behavior in non-urban environments. Nevertheless, trigonometric models suggest subtle but significant adjustments in activity related to urban intensity, potentially reflecting fine-scale temporal avoidance of human disturbance.
Further results on other urban mammal species (e.g., European badger *Meles meles*, grey wolf *Canis lupus*, and wild boar *Sus scrofa*) will contribute to a better understanding of their behavioral plasticity, highlighting the importance of the temporal niche dimension in facilitating species persistence in anthropogenic landscapes.

Urban wolves are less fearful of novelty, but more vigilant of change than wilder-living wolves. All however are scared of humans.

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Large carnivores recolonizing human-dominated landscapes face novel risks and opportunities, yet the behavioural mechanisms enabling this expansion remain poorly understood. Behavioural flexibility is considered one of the most effective ways for wide-ranging predators to persist in urbanized environments, allowing rapid adjustment to human-related environments without requiring genetic change. Here, we experimentally tested how urbanization affects fear-related behaviours in free-ranging grey wolves (*Canis lupus*) and whether responses depend on cue type and social context.

We tested 185 individually identified wolves across 44 locations in central Italy spanning a broad urbanization gradient (Human Footprint Index: ~10–44). Wolves were exposed to (i) novel objects as indirect cues of human presence and (ii) acoustic playbacks of human voices as direct cues, with repeated exposures allowing assessment of habituation.

Wolves from more urbanized areas were less likely to show fear during initial exposure to a novel object, indicating reduced neophobia. However, when a slightly different object was introduced, urban wolves showed renewed caution, whereas wolves from less urbanized areas generalized their reduced fear. In contrast, human voices elicited strong fear responses in over 80% of observations regardless of urbanization level, demonstrating that direct cues of human presence remain highly salient. Across both tests, wolves habituated rapidly, highlighting strong learning abilities. Sociality consistently buffered fear, with wolves encountering stimuli in groups responding less fearfully than solitary individuals.

Our results show that urbanization does not lead to a simple reduction in fearfulness. Instead, wolves flexibly modulate their behavioural responses depending on cue type and social context, balancing risk avoidance with exploration. This nuanced behavioural plasticity likely underpins wolves' capacity to persist in increasingly human-dominated landscapes and has important implications for managing human–wolf coexistence.

Space use response of roe deer to the return of the grey wolf in an alpine area

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Following the recolonization of a predator, prey may alter their habitat selection by shifting their home range closer to human settlements or by avoiding particularly risky sites. At the same time, selecting habitat close to humans might expose prey to both lethal and non-lethal risks. Therefore, when predators recolonize highly anthropogenic landscapes, prey are squeezed between the risk associated with humans and natural predators. Assessing how prey behave with respect to these pressures is important to increase the understanding of new ecological relationships emerging from the return of a predator. We investigated how the return of wolf (*Canis lupus*) after more than one century of absence influences the space use patterns of a of roe deer (*Capreolus capreolus*) in a peri-urban area in the Central Italian Alps (Cembra valley). Specifically, we tested the human shield hypothesis to verify whether roe deer selected for areas closer to human settlements when exposed to predation risk. Further, we verified whether the use of supplemental feeding sites, where roe deer gain food but are likely more exposed to predation risk (risk control hypothesis), changed in relation to the presence of the predator. We used GPS telemetry data of radio-collared roe deer collected before and after the recolonization of the area by wolves to investigate habitat selection by roe deer, at the second and third order level. First, we constructed a Resource Selection Function (RSF) to model how the settlement of the home range varied in function of the distance from human settlements and supplemental feeding sites in interaction with the presence of wolf (second-order habitat selection). Then, we used integrated Step Selection Analysis (iSSA) to investigate how the selection within the home range (third order habitat selection) varied in function of these same variables.
After wolf recolonization, roe deer set their home ranges closer to human settlements and marginally selected for areas closer to feeding sites. When looking at space use patterns within the home range however, the presence of wolves had no significant effects on roe deer habitat selection with respect to either human settlements or feeding sites.
Our results provide partial support for the human shield hypothesis, as roe deer tended to shift their home ranges closer to human settlements in the presence of wolves, but did not significantly alter their use of areas near human settlements within their ranges. Additionally, the finding that roe deer shifted their home ranges closer to feeding sites, without altering their finer-scale habitat selection for these features, suggests that roe deer continue to utilize feeding sites in the presence of wolves, but they reduce long distance movements to these sites to mitigate exposure to predation risk.

Hunting and outdoor recreation affect large herbivore activity patterns more than natural predators in a human-dominated landscape

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Across Europe, landscapes where large carnivores, large herbivores, and human communities coexist are expanding, reflecting the widespread recovery of large mammal populations in recent decades. The influence of top-down effects of wolves on large herbivores has been extensively studied in areas with relatively little anthropogenic disturbance, but less is known about their effect in human- dominated landscapes.
We systematically collected camera-trap data over five consecutive autumn hunting seasons in an area of the eastern Alps which is intensely frequented by tourists and trekkers, and partially open to ungulate hunting. We used a quasi-experimental design, with half of the sampling sites located within non-hunting areas and half outside. Applying generalised additive mixed models (GAMMs) with cyclic cubic splines we investigated the effect of wolf, as well as lethal (hunting) and non-lethal (recreational) human activities on red deer spatio-temporal activity pattern. Similarly, we analysed the effect of recreational activities and red deer site-use on the spatio-temporal activity pattern of wolves.
Hunting was associated with overall lower red deer activity, as well as reduced dawn-dusk peaks and diurnality. Crucially, hunting interacted with outdoor recreation exacerbating its effect, with major changes to red deer activity curve. Wolf site-use did not have a significant effect on the shape of red deer temporal curve. Wolves were markedly more active in areas highly used by red deer, and remained strongly nocturnal even where human activity was scarce.
Our results show that humans, through both lethal and non-lethal activities, elicit stronger responses in red deer than their natural predator. Behavioural constraints imposed by humans on red deer, coupled with the cursorial predatory strategy of wolves, likely limit the possibility of wolf avoidance by red deer. In human-dominated European landscapes, human disturbance can therefore override natural predator-prey dynamics, reshaping behavioural landscapes and potentially increasing predator and prey spatio-temporal co-occurrence.

Urban environments and the structure of animal personality: insights from a native rodent

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Human-driven environmental change is profoundly altering natural ecosystems, with urbanisation creating habitats characterised by novel ecological dynamics. Although behavioural variation can influence fitness, population processes, and ecosystem functioning, the role of animal personality and its variance components in urban adaptation remains insufficiently understood. Activity, exploration, and sociability—together with among- and within-individual variance—may shape behavioural responses to urban environments by influencing resource use, movement, tolerance to human disturbance, and conspecific interactions. The among-individual variance allows an adaptive evolution among generations: a greater phenotypic variation increases the likelihood that some individuals will exhibit well-suited behaviours to changing environments. Within-individual variance supports phenotypic change within a generation, allowing a faster adjustment to novel situations, a process important in highly dynamic environments, such as urban areas.
To address this knowledge gap, we examined whether the average expression of these traits and their variance components differed among urban, suburban, and rural populations. We used the Eurasian red squirrel (*Sciurus vulgaris*) as a model species, since it regularly occurs in urban parks and gardens, where it holds recreational and educational value, contributing to human well-being. We selected 6 study sites in urban areas, 3 in suburban and 3 in rural ones. A total of 490 arena tests were repeated on 169 Eurasian red squirrels (*Sciurus vulgaris*) across trapping sessions and squirrel densities, to estimate the expression of personality traits. The arena test combined a 4-minute open field test (OFT) followed by a 3-minute mirror image stimulation test (MIS). Red squirrel's behaviours were recorded with a web camera, then grouped into personality traits using an expert-based approach. Mean levels of activity and exploration (OFT), and social tendency (MIS) did not differ among populations experiencing different degrees of urbanisation, even if exploration decreased at higher population densities. However, we observed minor changes in the variance components of all personality traits. Rural populations exhibited greater heterogeneity (higher among-individual variance) in exploration and social tendency respect to urban sites, whereas individuals from suburban populations showed higher behavioural flexibility (greater within-individual variance) in activity compared with their rural conspecifics. These findings indicate that urbanisation may not impose strong directional selection on behavioural traits in this species; rather, local ecological conditions—such as spatial and temporal habitat heterogeneity, predation pressure, and population density—are likely to shape both personality consistency and intra-individual behavioural flexibility. Suburban environments, which integrate characteristics of both rural and urban systems, are exposed to variable levels of anthropogenic disturbance, and may therefore represent a valuable context for urban ecological research. Our results contribute to understanding how both among- and within-individual differences in behaviour vary across the urbanisation gradient, a topic that remains insufficiently investigated despite its relevance to ecological and evolutionary processes and to population management, as such variation may facilitate adaptive responses to highly dynamic urban environments.

Dispersing processes, not just seeds: individual small mammals drive seed–mycorrhizal co-dispersal beyond species' ranges

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Range expansion of tree species under climate change depends not only on seed dispersal but also on ecological interactions that facilitate successful establishment. This process involves both the placement of seeds in microsites suitable for germination and the co-dispersal of their mutualistic fungal symbionts. For heavy-seeded species such as oaks, small mammals play a key role by independently dispersing seeds and mycorrhizal fungal spores, thus mediating the establishment of tree–fungus symbioses in new areas. Previous work has shown that seed dispersal varies intraspecifically, partly driven by individual personality. However, whether such variation influences the set of ecological interactions affecting tree species establishment remains unknown. This question is crucial, as personality may differentially affect the efficiency of seed and spore dispersal. Here, we ask whether individual personality differences influence the effectiveness of seed and spore dispersal as an ecological process. With the goal of identifying generalizable rules governing the dispersal of multiple interacting species, such as mutualistic partners, we conducted a series of field experiments on (1) seed dispersal, (2) truffle detection, (3) mycorrhizal fungal spore dispersal, (4) mycorrhizal fungal spore viability, and (5) mycorrhization establishment. Experiments were conducted in the Julian Prealps Natural Park (north eastern Italy) between May and October of 2024 and 2025, encompassing 21,600 trap-nights, as part of a capture–mark–recapture study. Rodent personality was measured in 119 *Apodemus flavicollis* and 97 *Clethrionomys glareolus* individuals using standardized open-field, emergence, and handling tests. Seed dispersal was assessed through two series of experiments (i) using artificial acorns varying in tannin and nutrient content, and (ii) using acorns from four oak species. We measured 1768 rodent–seed interactions with infrared cameras and RFID readers, and assessed fate, dispersal distance, and caching behavior. During 2025, we also conducted experiments to test individual-level efficiency in detecting artificial truffles (474 detections). Furthermore, by examining 289 fecal samples collected across both years we quantified the abundance and species richness of mycorrhizal spores. Finally, we conducted spore viability assays and mycorrhization experiments with six oak species to evaluate successful mycorrhization. Our results reveal clear, general rules governing seed selection. When seed mass—and thus manipulation cost—was constant, rodents preferred seeds with higher nutrient content; when mass varied, tannin content emerged as the dominant trait driving seed selection. High-tannin seeds were more likely cached, while low-tannin and low-nutrient seeds were eaten immediately. Personality traits modulated seed decisions thus directly influencing dispersal effectiveness. Individuals also varied in truffle detection and spore dispersal, with some contributing disproportionately to mycorrhizal dispersal. Finally, fungal spores remained viable after passage through the rodent gut, and oaks inoculated with rodent feaces successfully established mycorrhizal associations. Range expansion depends not only on seed movement but on the co-dispersal of symbionts required for establishment. Our findings demonstrate that small mammals act as vectors of seed–mycorrhizal symbioses beyond the current distributions of plant and fungal species, effectively dispersing an entire mutualism beyond current range distribution limits. This function is strongly heterogeneous among individuals due to behavioral variation, with a minority driving most of the co-dispersal.

SESSIONE 3.

Uomini e mammiferi: implicazioni sociali, economiche e sanitarie

ETHAS: an ethical self-assessment framework for responsible mammal research and monitoring practices

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Mammal research and monitoring activities occur in a highly complex operational and decision-making environment, where scientific and conservation objectives must be continuously weighed against social expectations, animal welfare concerns and regulatory constraints. In a scenario of growing public attention to animal welfare, these trade-offs become particularly evident when projects involve direct interventions on wild animals, such as capture, immobilization and marking, which are often necessary to address specific research or management needs. In this sense, decisions regarding methods and procedures are never merely technical; rather, they carry with them a strong ethical component: they involve weighing potentially competing objectives and priorities, with direct implications for the legitimacy and acceptability of the activities being carried out. To face these challenges, there is a need for tools capable of supporting ethical decision-making in fieldwork. This contribution aims to present an ethical self-assessment tool based on checklists, designed to support professionals involved in mammal research and monitoring activities that involve direct interventions on live wild animals.

The tool presented here is based on ETHAS, an ethical self-assessment framework already applied in other settings of biodiversity conservation, here adapted to the specific needs of mammal research and monitoring activities in the field. This customization was carried out through an integrated approach, combining: a) a review of scientific literature, regulations and operational guidelines and best practices; and b) semi-structured interviews with professionals (n=30), including researchers, wildlife managers and veterinarians, conducted across Europe and the United States. This approach allowed to identify the main ethical and decision-making challenges related to the design and implementation of field activities, directly informing the structure and content of the ETHAS checklists. Our research highlights a pronounced heterogeneity in field practices, which strongly depend on ecological, social and regulatory contexts, as well as on the specific objectives of the projects. Yet, many ethically relevant decisions, with potential implications for involved animals, ecosystems, people and the quality of the data collected, are often made under conditions of uncertainty and without explicit and shared guiding principles. At the same time, our research reveals a widespread caution toward binding operational protocols, which are often perceived as poorly suited to addressing the unpredictability of field activities. Additionally, relevant differences were found in authorization and ethical oversight processes, even when the procedures in question are substantially similar: levels of scrutiny vary across geographical and institutional contexts, contributing to uneven operational standards. In this scenario, ETHAS emerges as a tool aimed to address the identified challenges. Conceived to support conservation professionals in guiding and justifying their choices, ETHAS allows to make the ethical evaluations underlying operational decisions explicit and structured. Within the checklists, ethically relevant aspects are organized along four main dimensions (animal welfare, environmental ethics, social ethics and research ethics), offering a shared ethical framework that is applicable regardless of the ecological, social or institutional context, while making space for context-specific evaluations informed by practitioners' direct experience. By promoting ethical reflection and continuous refinement of procedures, ETHAS strengthens the transparency, justifiability and communicability of the decisions adopted, providing concrete support to professionals operating within an ever evolving social and regulatory landscape.

Widespread *Toxoplasma gondii* infection in expanding wolf populations in Italy

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The expansion of wolves (*Canis lupus*) into human-dominated landscapes across Italy has intensified ecological and social interactions at the human-wildlife interface. Within a One Health perspective, zoonotic pathogens such as *Toxoplasma gondii* are of particular interest because of their broad host range and their potential to influence animal behaviour, with possible consequences for mortality risk, space use, and coexistence with humans. In wolves, *T. gondii* infection has been linked to altered behavioural patterns, suggesting possible implications for individual risk-taking and exposure pathways.
We investigated the prevalence of *T. gondii* infection in Italian wolves and its relationship with ecological context and proxies of risky behaviour. We analysed biological samples collected from wolves across Italy between 2020 and 2024, including both carcass-based (N=312) and live-captured individuals (N=25). Infection was assessed through serological detection of anti-*T. gondii* IgG and molecular screening of heart and central nervous system tissues. Anthropogenic pressure was characterised at a spatial scale relevant to wolf ecology using the Human Footprint Index integrated within circular areas approximating average home-range size. Using the same spatial framework, overlap with wildcat presence was estimated as an indicator of potential exposure to felid hosts.
Positivity was broadly homogeneous across monitored areas, with no evident spatial structuring at the scale considered. Among dead wolves, *T. gondii* seropositivity increased with age, with individuals older than one year showing higher infection probability than juveniles, while no differences were detected between sexes. No clear association emerged between infection status and anthropogenic pressure, wildcat overlap, or indicators of risk-prone mortality. In contrast, 80% of live-captured wolves were seropositive for *T. gondii*, compared with an overall positivity of 32% in the carcass sample (serology and PCR combined).
This study provides the first large-scale assessment of *Toxoplasma gondii* infection in wolves in Italy, based on an extensive dataset spanning a wide latitudinal gradient from northern to southern regions.
The notably high prevalence observed in live-captured wolves, combined with the lack of marked spatial clustering, suggests that infection patterns may be shaped by processes operating at the level of individual wolves rather than by broad-scale environmental gradients. By integrating epidemiological and spatial information at a national scale, this work contributes novel insights into *T. gondii* circulation in expanding wolf populations and raises relevant questions about the links between infection, behaviour, and exposure in human-influenced landscapes.

Outsmarting the trickster, epidemiology and anatomical distribution of *Toxoplasma gondii* in the brain of red foxes from Italy and Australia

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Urban expansion, landscape fragmentation, habitat loss and changes in wildlife perception are all factors at play in the intensification of interactions between humans and wild animals, with relevant ecological, socio-economic and sanitary implications. The study of pathogen circulation in synanthropic mammals is beneficial not only for public and animal health, but also to promote management strategies of coexistence between humans and wildlife in ever increasingly shared environments. Among wild mammals, generalist carnivores like the red fox (*Vulpes vulpes*) are particularly proficient in exploiting the wild-domestic interface searching for food and shelter. Their role as scavengers, the extremely wide dietary breadth and the use of urban environments make of foxes great epidemiological sentinels for the circulation of several zoonotic pathogens. *Toxoplasma gondii*, is an apicomplexan protozoan with a cosmopolitan distribution and usually associated with its feline definitive host. *Toxoplasma gondii* is particular impactful on pregnant women and in livestock production as it is one of the main aborting agents in sheep and goats. Acute toxoplasmosis can be fatal in both humans and animals, in particular for species that did not coevolve with the parasite, such as cetaceans, marsupials or new-world monkeys. *Toxoplasma gondii* has also been known to cause behavioral alterations. A specific behavioral syndrome, called dopey fox syndrome, has been associated to *T. gondii* infection occurring in red foxes, that exhibited reduced neophobia and aberrant behaviors.
Red foxes were collected from a wildlife rescue center and from roadkills in Italy and within pest control efforts in Australia. Serological analyses were performed using an indirect immunofluorescent antibody test and a modified agglutination test on sera of Italian and Australian foxes respectively. Molecular detection and *T. gondii* genotyping through multilocus RFLP was carried out from tissue pools collected from Australian foxes. Multivariable logistic regression models were applied to identify epidemiological predictors of infection. Whole brains of seropositive foxes were fixed and examined through histopathological, immunohistochemical and molecular analyses to investigate the anatomical distribution of lesions and *T. gondii* parasitic elements.
Serological testing confirmed widespread exposure of red foxes to *T. gondii* in both Italy (68.5%) and Australia (38.9%), with adults and foxes from Southern Italy, and heavier foxes from Australia that were significantly more seropositive. Molecular analyses revealed active infections and a predominance of the clonal Type II along with novel Type II-like genotypes, while neuropathological investigations identified focal to multifocal inflammatory and necrotizing lesion along with parasitic elements in brain areas involved in decision-making and fear processing in 17% of seropositive foxes. These results confirm that red foxes are effective sentinels for zoonotic parasites highlighting their role in signaling *T. gondii* circulation in two radically different environments. The detection of brain lesions in functionally relevant areas suggests that toxoplasmosis could influence fox behavior, possibly leading them to be less fearful and more reliant of the human dominated landscape. Such behavioral alterations could be at play also in foraging strategies and predator or risk avoidance, triggering a cascade of ecological effects that will indirectly affect the human perception of this mesocarnivore and the need for management strategies to reduce conflicts.

Habitat, disturbance, and human perception: wolves at the edge of Mongolia's capital city

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Mongolia's long-standing nomadic and semi-nomadic traditions are closely linked to a deep body of Traditional Ecological Knowledge (TEK), within which wolves hold strong cultural, historical, and ecological significance. Ecologically, wolves are opportunistic predators whose broad diets often overlap with human activities, leading to conflict with livestock and people. Rapid urban expansion around Ulaanbaatar has intensified these pressures, particularly at the wildland–urban interface of Bogd Khan Mountain Strictly Protected Area, a UNESCO Biosphere Reserve and the oldest protected area in Eurasia. Understanding wolf conservation in this landscape requires integrating ecological processes with social perceptions shaped by both tradition and modernization.

From 2022 to 2023, we deployed 72 camera traps across Bogd Khan Mountain (11,539 trap nights) using a random habitat-stratified design to assess wolf abundance, diel activity, and spatial co-occurrence with free-ranging dogs, livestock, wild ungulates, and human activity. Abundance modeling was used to evaluate spatial associations and temporal overlap among species. In parallel, we conducted surveys of residents living near the protected area to document local perceptions, cultural values, and management practices related to wolves, with particular attention to the role of TEK in wildlife management.

Wolves exhibited primarily nocturnal and crepuscular activity, with the greatest temporal overlap occurring with wild prey species, including wapiti and Siberian roe deer. Moderate overlap was observed with free-ranging dogs and horses, while overlap with cattle and people was minimal. Wolf abundance increased with higher relative abundance of wild ungulates and in areas with greater human presence. Dogs co-occurred with wolves at a limited number of sites, though their effect on wolf abundance was marginal. Survey responses revealed a diversity of attitudes, with many residents acknowledging the cultural importance of wolves while expressing concern over livestock depredation.

These results highlight the complex ecological and social dynamics shaping wolf persistence at Mongolia's expanding wildland–urban interface. While ecological findings emphasize the importance of prey availability and spatial behavior, social data underscore the continued relevance of TEK in contemporary conservation. Integrating TEK into management strategies offers opportunities for culturally sensitive and ecologically sound conservation, though challenges to accessing and applying this knowledge remain. Effective wolf management in Bogd Khan Mountain will require approaches that balance ecological realities with evolving human needs to ensure the long-term sustainability of this iconic species.

Ecological repellents for the protection of vineyards from damage caused by wildlife in the Cinque Terre National Park

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Since the second half of the 20th century, the Liguria Region, as well as the rest of Italy, has seen an increase in wild ungulate populations, leading to greater damage to agricultural and forestry crops and increased risks (road accidents). Based on data provided by local authorities to ISPRA for the period 2015-2021, damage to agriculture caused by ungulates averaged €1.7 billion per year. Frequent incursions by wildlife, particularly wild boars and roe deers, have also been recorded in the fragile territory of Cinque Terre National Park, which is characterised by small, terraced vineyards of high economic and cultural value.
For this reason, starting in 2015, the Park Authority implemented a set of non-lethal, low impact protection systems to safeguard production, in order to mitigate conflicts between starling and agricultural activities. Specifically, this contribution presents the results of testing a biological repellent that acts as an olfactory-gustatory deterrent for roe deer, as well as the farm's assessments of the use of the aforementioned phytosanitary product. The water-based repellent containing sheep fat (6.39%) was tested in spring 2022 on experimental plots of two farms.
Both farms have terraced vineyards, although traditional cultivation systems are also common. The work methodology was scheduled based on the vine's vegetative stages and included three applications of the repellent, rather than two, due to a delay in the pre-flowering phase. The methods and dosages of use involved diluting the formulation in water in a ratio of 1/3 – 1/5, with water at a ratio of 1/3 to 1/5, resulting in a compound application rate of 10-15 L/ha. Pre and post-treatment behavior of wild animals was monitored using camera traps.
Following the encouraging results obtained in the first years of testing, the Park decided to provide the repellent free of charge to farmers who requested it in subsequent years as well. In order to assess farmers' satisfaction with the proposed protection system, questionnaires were distributed to 41 and 34 farms in 2023 and 2024, respectively. The questionnaires were designed to provide technical feedback on the repellent and perceptual-social assessments related to ongoing human-wildlife interactions affecting the farms' economic dynamics. The experiment results showed that roe deer visited the study areas only occasionally, with 14 sightings during the spring phase of repellent application, allowing the vines to remain undamaged during the vegetative-reproductive growth stage (particularly during budding) and to reach near-optimal fruit ripening.
The excellent results achieved by applying this system to protect against roe deer browsing were confirmed by farmers' positive assessments of the repellent's effectiveness and satisfaction. More than 75% of respondents reported no browsing episodes, and 80% said they would use the repellent again the following season and recommend it to others. The most critical issues for farmers appear to be socially related, due to the additional burden of caring for their fields caused by wildlife perceived as undesirable and unfamiliar to their territory. Scientific assessments of the adopted protection system, combined with feedback from farmers, will provide the Park Authority with important information to evaluate the appropriateness and coherence of the resources invested, with the aim of developing a policy to reduce damage and minimise conflicts. Notably, the good results achieved with repellents have, for now, eliminated the need to consider a roe deer population control plan within the protected area.

Lost in estimation: the fragility of density-based approaches for ordinary wildlife control and sanitary risk management

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In wildlife management and the One Health framework, animal density is the primary metric for assessing zoonotic risks and defining culling or vaccination strategies. While camera trapping and Random Encounter Models (REM) are increasingly proposed as cost-effective and easy-to-apply alternatives for monitoring, their reliability as a foundation for sanitary protocols remains debated. We initiated a long-term study to evaluate whether REM-derived estimates provide a robust basis for ungulate management compared to established „gold standard" methods. Between 2022 and 2025, we monitored wild boar (Sus scrofa) and fallow deer (Dama dama) in the 60 km2 Presidential Estate of Castelporziano (Rome, Italy). We compared high-intensity camera trapping (1.4 CTs/km2; REM/Agouti protocol) against Nocturnal Line Transect Sampling (NLTS), the latter validated as a „gold standard" through rigorous testing of distance sampling assumptions. Both methods targeted species under annual control plans to mitigate impacts on forest regeneration and biodiversity.
Statistical analysis confirms that wild boar significantly outnumber fallow deer across all study years ($\beta = 21.8 \pm 5.6$, $p < 0.001$), regardless of the estimation technique used. However, the two methods produce substantially different absolute density values. NLTS yielded consistently higher estimates than REM: 30 – 50% greater for wild boar (NLTS: 19.8–59.2 ind/km²; REM: 18.7–39.1 ind/km²) and 112 – >600% greater for fallow deer (NLTS: 5.2–13.3 ind/km²; REM: 0.5–6.3 ind/km²). This discrepancy is particularly pronounced for fallow deer, where REM estimates appear as clear underestimates. In several cases, the number of animals removed during culling operations either exceeded the total REM-estimated population or represented such a high proportion of it that the removals would have been ecologically unsustainable (high-impact environmental control techniques) had the estimates been accurate. While both methods captured a synchronous population decline in both species from 2022 to 2025 ($F=0.13$, $p=0.9$), they diverged sharply in describing community structure. The geometric mean wild boar:fallow deer ratio was 4:1 according to NLTS, but surged to 13:1 with REM. This threefold difference in perceived community imbalance highlights REM's hypersensitivity and poor precision for low-density fallow deer populations (< 2 ind/km²), whereas both techniques showed similar precision (CV < 20%) for estimating higher-density wild boar populations. Notably, these significant discrepancies emerged within the „controlled" context of a fenced reserve with closed populations, despite exhaustive sampling efforts involving high-end equipment and specialized personnel. This suggests that in open systems, where biological and environmental variables are far less constrained, the use of unvalidated density estimates must be approached with even greater caution.
Such methodological uncertainties create a ‚false scientific floor' for policymakers. Particularly in the context of African Swine Fever (ASF), where achieving specific threshold densities is

critical to halting viral transmission, relying on biased or unvalidated metrics could result in culling efforts that are not adequately targeted, allowing the pathogen to persist and spread. Propagating these local-scale errors to regional levels risks the adoption of strategies that are ineffective or poorly calibrated to local operational capacities. The budgetary implications are equally stark: when management costs are calculated per capita, even a minor deviation in density estimates can trigger massive funding gaps, severely compromising both the scale and the continuity of interventions. Our findings suggest that basing sanitary or wildlife management solely on census data can lead to fundamentally flawed strategies. We therefore advocate for a multi-parametric governance model that integrates environmental and ecological indicators. This approach reduces sensitivity to the biases of density estimations, fostering a more resilient response to real population dynamics.

Bushmeat trade and implication for Great Ape conservation in Cameroon

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The Bushmeat study was conducted in southern Cameroon as part of the environmental impact assessment associated with the upgrade of a major road infrastructure in the region. The area hosts confirmed population of Great Apes, specifically the endangered central chimpanzee (*Pan troglodytes troglodytes*) and the critically endangered western lowland gorilla (*Gorilla gorilla gorilla*). In alignment with international environmental standards commonly applied by development finance institutions, a technical consultation process was initiated with the IUCN/SSC Primate Specialist Group – Section on Great Apes. The main objective of this study was to investigate the current bushmeat hunting, trade and consumption, to understand how the improvement of the infrastructure and road-related immigration may intensify these dynamics and consequently heighten pressure on Great Apes populations, as well as to develop site-specific recommendations aimed at mitigating these predicted impacts. The study adopted a multi-scale research design combining bibliographic reviews (from regional to international level) with field-based investigations and structured stakeholder engagement. Data collection comprised: (i) interviews with 209 local people (with hunters, farmers, and/or officials from governmental organizations) across 20 villages along the road; (ii) Great Apes field surveys carried out through distance sampling technique (recces) and camera trapping during both wet and dry seasons; (iii) general biodiversity transects, plot and interviews with local people conducted between 2021 and 2023; and (iv) supplementary interviews undertaken in the context of stakeholder engagement activities in 2024. The review of existing literature indicates that bushmeat in Cameroon is predominantly transported in Yaoundè markets (the capital) from the Nord, Central, and South regions, which are characterized by high wildlife abundance and the presence of several national parks and safari hunting areas. Species sold in local markets are primarily mammals, including taxa listed as Critically Endangered, Endangered, or Vulnerable by the IUCN, such as pangolins, great apes, and African civets. The present study reveals that bushmeat remains a critical source of protein and income for rural and periurban households along the route, and in Cameroon too, where consumption patterns strongly rely on forest resources. Most household heads reported working in agriculture, with a large proportion also identified as hunters. Hunting practices are dominated by snare use—often employing metal cables that pose severe risks to larger fauna—followed by shotguns, night jacklighting, and hunting with dogs. Spatial analysis indicated that human pressure on wildlife is widespread throughout the study area, including near the northern boundary of Campo Ma'an National Park, where pressure shows slight attenuation yet remains significant. Protein consumption patterns show a strong dependence on forest resources, with fish and bushmeat representing the primary sources of animal protein and consumed two to three times per week. Among hunters, 55% of harvested bushmeat is consumed within the household, while the remainder is sold locally, in nearby towns, or along transport routes. Market oriented interviewed additionally report purchasing bushmeat in 82% of cases, highlighting strong and persistent local demand. Illegal hunting is common and includes protected species such as pangolins, tortoises, chimpanzees, and gorillas, despite general awareness of wildlife laws among communities.

The present study proposes a set of mitigation and management measures to reduce the impacts of road construction on Great Apes and other wildlife. Key recommendations include zero tolerance for hunting protected species, strengthened wildlife controls along the road corridor, increased Ecoguard presence, strict hygiene protocols for all personnel, prohibition of domestic animals, and traffic calming measures such as speed limits and wildlife alert signage. Long term actions—potentially integrated into an Offset Strategy—encompass support for alternative protein sources, reinforcement of buffer zones near the national park, Ecoguard capacity building, and the establishment of long-term monitoring of bushmeat consumption and biodiversity trends. Overall, the study underscores the need for stronger law enforcement and inclusive governance involving local communities, park authorities, and national institutions to reduce human–wildlife conflict and promote more sustainable coexistence along the road corridor.

Use of environmental sampling for One Health surveillance of bats

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Interest for bats as carriers of microorganisms with zoonotic potential increased in the aftermath of the COVID-19 pandemic, leading to a surge in sampling efforts. While monitoring these animals is vital for safeguarding animal and human health, campaigns must be carefully balanced to minimize disturbance to bat populations and prevent unintended outcomes. For example, excessive stress could ultimately increase the likelihood of bats getting infected and shedding viruses. Novel approaches of environmental sampling are increasingly employed for disease surveillance in humans and animals. However, applying these approaches to sanitary surveillance requires developing standardized validated methods that guarantee sensitivity and repeatability across sampling occasions.

The CABLES (INTERREG ITAT 27 011) project seeks to establish a structured, feasible and sustainable surveillance that balances the diagnostic sensitivity with the impact on bats, while optimizing available resources. During the summer 2025, we combined classical active surveillance involving animal capture and individual sampling with environmental sampling, in order to identify strengths and weaknesses of non-invasive programs. We targeted four mixed colonies of *Myotis myotis/Myotis blythii* in the Province of Bolzano, capturing bats to collect faeces, salivary swabs, patageal swabs, ectoparasites and, from two sites, blood. Capture of bats was authorized by the Ministry of Agriculture in compliance with Directive 1 and was performed by highly trained personnel including chiropterologists, biologists and veterinarians. We tested two approaches for the standardized non-invasive collection of faeces, including chart paper and overshoes developed to increase virus collection. We collected air samples using the Coriolis® compact and performed an entomological capture, using a manual aspirator for Cimex found within the environment and CDC-CO2 traps. We compared different laboratory techniques for the pre-treatment of environmental samples and for the extraction of DNA and RNA, in order to secure the best performances for the detection of viruses, parasites, bacteria and fungi. We then analysed individual and environmental samples for the presence of microorganisms, using metagenomics approaches and broad-spectrum molecular techniques for viruses, bacteria, parasites and fungi.

During one season, we performed five sampling campaigns, with repeated sampling at one site. We aimed for a minimum sample size of 30 individuals that, based on population size, ensures the detection of microorganisms circulating at 10% prevalence or higher. Nevertheless, the campaigns allowed captures of 14-40 individuals, with the number of faecal samples further reduced to the individuals actually defecating between capture and release. In turn, the individual sampling that is usually employed for serological surveillance of lyssaviruses proved to be poorly sensitive for molecular detection. Indeed, only 5 individuals were positive for coronaviruses in the salivary swabs, regardless of their known circulation within target roosts. On the other hand, environmental surveillance allowed for the collection of standardized pooled samples, increasing chances for virus identification. Arthropods showing a blood meal could be successfully used to study microorganisms with a haematic phase, while air sampling could detect a broad range of agents shed through the respiratory and gastrointestinal routes. Environmental samples could also be used for the identification of the bat species present in the colony, with promising results for ecological monitoring.

In conclusion, we were able to implement a standardized environmental surveillance that requires no technical expertise during sample collection and that can integrate ecological and sanitary purposes with minimal impact for bat populations.

Are electric fences an effective preventive measure for protecting agricultural production?

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During the 20th century, major socio-economic changes affected Italy and Liguria, following the progressive depopulation of mountain areas and the consequent abandonment of agriculture giving space to natural reforestation: in this context, large mammals began to reappear. The Cinque Terre National Park is famous worldwide for its characteristic terraces supported by dry stone walls, which extend from the shore line to about 500 metres above sea level and were built to make land, with a slope of up to 70%, cultivable the vineyards have limited extension, are characterised by the fragmentation of properties, and do not allow the use mechanical equipment: today there are 25 agricultural producers with an average area of 0.36 hectares, alongside 500 suppliers. The abandonment of agricultural practices in the Park has led to the creation of a mosaic of crops, brambles and shrubs in which wild boars have found an ideal habitat, causing economic damage to wine production and dry-stone walls, and generating conflicts with the remaining agricultural activities. Since 2000, the Park Authority has implemented a wild boar control plan aimed at reducing damage and conflicts, which includes not only population control but also preventive activities through the adoption of district fencing systems and the provision of 126 electric fences on loan to 98 beneficiaries.
Given the difficulty of assessing in absolute terms the effectiveness of a prevention and protection system that covers plots of limited size, in 2024 it was decided to submit a questionnaire to those who had benefited from these tools, which had been provided free of charge by the Park Authority. The interviews were conducted through various channels: in person, by telephone or by email/WhatsApp. It was possible to contact 82 fence owners, 71 of whom responded to the questionnaire and had a total of 98 electric fences at their disposal.
The fences are mainly installed to protect vineyards (60% of cases) and olive groves (14%), 83% of respondents reported they were satisfied with the prevention measures, 47% said they had since stopped suffering damages from wild boars, and 80% of satisfied users would be willing to recommend these prevention methods to others. As for those who decided to abandon these tools, in most cases they did not consider the system effective (31%), and in 19% of cases, the abandonment was caused by the fact that the landowners did not live near the cultivated plots. In general, respondents voiced their concerns on the excessive operational costs of maintenance.
The survey highlighted how these prevention tools have proven effective in reducing damage and conflicts in areas characterised by fragmented ownership and with large portions suitable for large mammals prone to entry in high agricultural value areas. At the same time, the need to invest more in communication is clear in order to reach an increasing number of stakeholders, providing comprehensive and accurate information on wild boar management tools and approaches at grassroot level.

No evidence of intraspecific scavenging behavior in wild boar. Is the carcass-driven transmission of African swine fever overestimated in the Mediterranean context?

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African swine fever (ASF), a viral infection originating from African wild suids, threatens wild boar and domestic pig populations, carrying severe implications for animal health and international trade. The ongoing European epidemic, which began in 2007 and reached Italy in 2022, causes significant mortality in wild boar. In affected regions, a considerable number of wild boars die from the infection, thus becoming available to scavengers; these carcasses can remain infectious for several months posing a risk of transmitting the disease to other wild boars. Consequently, infectious carcasses serves not only as an important resource for scavenger communities, but also as persistent viral reservoirs of ASF. However, current understanding of the role played by carcasses in infection dynamics is derived almost exclusively from Central and Northern Europe, where climates and scavenger communities differ greatly from those in Mediterranean ecosystems.

To address this pivotal geographical knowledge gap, we conducted an experimental study at the Presidential Estate of Castelporziano (Rome, Italy), mainly aimed to: (I) identify necrophagous vertebrate species and quantify their visitation and use of carcasses, (II) confirm the occurrence and frequency of intraspecific scavenging (cannibalism) in wild boar, (III) assess the frequency of direct and indirect contact between live wild boars and carcass, (IV) determine carcass persistence time and temporal dynamics of consumption.

During Autumn-Winter 2025, we identified 20 experimental sites where wild boar carcasses were deployed. Each site was equipped with three camera traps. To quantify carcass attractiveness, a control site (also equipped with camera traps but without a carcass) was set up at a distance of at least 200 m from each experimental site. Sites were equally divided between those mimicking natural ASF „death beds“ and randomly selected points. Camera traps were programmed to record 20-second videos, with a 1-second interval. Carcasses originated from the estate‘s population control program and were deployed in the experimental sites within a maximum of 18 hours post-mortem. Carcass consumption and degradation were quantified daily via video review, supplemented by field surveys every three days. Monitoring continued until each carcass had completely or substantially disappeared. The sample consisted of 11 females and 9 males, 2 aged between 0 and 12 months, 2 between 13 and 24 months and 16 > 24 months. The average weight of the animals was 67.4 kg (sd = 19.3 kg). A total of over 80,000 videos were collected, lasting more than 400 hours. The average persistence time of carcasses was 21.6 days (range 4 - 38 days). All carcasses were consumed or dismembered by scavengers before reaching the stage of complete skeletonization. The number of species of scavenging vertebrates that visited the carcasses was very low. Approximately 90% of visits were by foxes and the remaining 10% by wolves, hooded crows and buzzards. We found no evidence of cannibalism or direct/indirect contact by wild boar with conspecific carcasses. Wild boars were rarely recorded on camera and never interacted with carcasses or the deathbed. Contrary to findings from northern and central Europe, scavenger activity in our Mediterranean study area drastically reduced carcass persistence. This marked reduction, coupled with the absence of post-mortem intraspecific scavenging and contact, needs to be confirmed by further experimental evaluations but suggests that carcasses may act as a less critical driver of ASF transmission in similar ecosystems. These findings call for a critical reassessment of carcass-focused management priorities in Mediterranean ASF control strategies.

Predators at odds: contrasting wolf and human-induced mortality in red deer

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Human hunting and natural predation by large carnivores are two major sources of mortality in ungulate populations. The recent recolonization of the grey wolf *Canis lupus* in the Italian Alps, a highly human-modified landscape, may pose potential conflicts with several human activities, including hunting. Understanding how wolf predation interacts with human harvest, and in particular if – and to what extent – these two sources of mortality overlap, is important for assessing potential conflicts.

We investigated sex- and age-specific selectivity and mortality patterns of wolves and human hunters in a red deer *Cervus elaphus* population monitored over three years (2022–2024) in a system where hunters and wolf coexist. Using spotlight counts and camera-trap data, we reconstructed annual population structure and estimated the population available to predation and harvest. We then collected data on deer harvested during the hunting season and those predated by wolves within their territory. We quantified wolf and human selectivity using Jacobs' index and modelled the probability of wolf predation and human harvest across sex and age classes using generalized linear models. In addition, we used a data-based approach to assess whether individual body condition (Bone Marrow Fat) and the interaction between sex and age influenced the probability of being killed by wolves rather than hunters, augmented with Monte-Carlo simulations in order to account for imperfect detection of predated individuals.

Wolves and hunters showed distinctly different and non-overlapping selection patterns based on Jacobs' index. Wolves moderately selected calves and strongly under-selected adult males, while for adult females and yearlings did not show evidence of selectivity. In contrast, human hunters showed positive selection for yearlings, particularly males, whereas selection for other sex- and age-classes generally reflected the population structure. Model results showed a pronounced sex–age interaction in wolf predation, with adult males having a substantially lower probability of being killed by wolves compared to adult females. In contrast, hunting mortality did not show significant sex-age interaction among adults, while male yearlings had a higher probability of being harvest than female yearlings. Our data-based approach to compare wolf- and human-induced mortality showed that individuals in poorer condition were more likely to be predated by wolves than harvested by hunters. With regard to the interaction between sex and age, the model showed different patterns: similar probabilities of mortality induced by wolves and human in calves, an increasing probability of wolf predation on females with increasing age, and a decreasing probability in males, resulting in adult males being more likely to die because of hunting than because of wolf predation.

Our results suggest that wolves and hunters target different segments of the deer population, limiting direct competition for prey but potentially adding up mortality rates. These findings highlight the importance of considering natural and anthropogenic predation together when assessing ungulate population dynamics and designing wildlife management strategies in systems where large carnivores and hunters coexist.

Odi et amo: social perception of *Callosciurus finlaysonii* in Cilento National Park

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Callosciurus finlaysonii (Horsfield, 1823), commonly known as Finlayson's squirrel or variable squirrel, is a species of squirrel from Southeast Asia. It has established an allochthonous population in Southern Italy following its introduction as a pet in the 1980s in Maratea (Basilicata Region). The species is currently listed as an invasive alien species of Union Concern under Regulation (EU) 1143/2014. In recent years, *C. finlaysonii* has been expanding its range into the Campania Region, particularly within the southern portion of the Cilento, Vallo di Diano, and Alburni National Park, where the SAC "Montagne di Casalbuono" is located. Currently, there is limited knowledge regarding the impact of this species on both biodiversity and human activities. Furthermore, understanding public perception is crucial for planning effective control or eradication measures. To address this, we conducted a survey among the local population of the SAC "Montagne di Casalbuono" and neighboring municipalities. The primary objectives were to assess the species' distribution, identify the damage caused to human activities, and evaluate how the squirrel is perceived by the local community.
We conducted the survey as part of the R.A.MO.CA project "Roditori Arboricoli MOntagne di CAsalbuono", by administering a 26-item questionnaire to participants via face-to-face interviews. This approach ensured that all questions were interpreted correctly and answered accurately. The questionnaire was about all the Sciuridae and Gliridae species potentially present in the study area, with a focus on *C. finlaysonii*. The questionnaire was divided into four sections: i) personal data and demographics; ii) knowledge and distribution of *C. finlaysonii* and other Sciuridae and Gliridae species; iii) impact on human activities, focusing on both firsthand and reported damage; iv) public perception, including opinions on potential control or eradication initiatives. A total of 100 individuals were interviewed between July 2025 and January 2026 across the municipalities of Casalbuono, Casaletto Spartano, Caselle in Pittari, Sapri, Torraca, Tortorella, Buonabitacolo, Sanza, Lagonegro, Montesano sulla Marcellana, Morigerati, and Rivello.
The results confirm that *C. finlaysonii* is widely distributed throughout the study area. Numerous instances of damage to human activities were reported, primarily affecting crops (fruit trees and vegetables), infrastructure (electrical, telephone, and internet cables, as well as vehicle wiring), and irrigation systems. Additionally, significant tree bark stripping was noted. Public perception of the species is highly polarized: it is extremely negative among individuals who have suffered long-term direct damage, whereas the squirrel is more tolerated in recently colonized areas. Conversely, those who have not experienced firsthand damage maintain a very positive view, often perceiving the species' presence as aesthetically pleasing or charismatic.
The data presented in this study represent one of the first formal documentation of the damage caused by *C. finlaysonii* in the study area, as well as the local population's perception of the species. Although these results are preliminary, they allow for several key conclusions. The damage caused by the species—while requiring more detailed quantitative assessment—is evident and poorly tolerated by a significant portion of the local community. Conversely, another segment of the population appreciates the animal's presence, often disregarding its status as an invasive species that, by law, requires control or eradication. Consequently, before implementing any management actions, it is imperative to launch awareness and information campaigns regarding the impact of invasive alien species in general, and *C. finlaysonii* in particular.

Longitudinal dynamics of rural attitudes and fear during wolf recovery in the Italian Alps

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The ongoing recovery of large carnivores is regarded as a conservation success. Yet it poses persistent social challenges, particularly for rural communities at the center of this evolving and often conflictual human-wildlife relationship. Despite this, longitudinal studies that track the evolution of rural acceptance through different stages of recolonization remain rare.
We monitored public attitudes and fear responses across six rural areas in the Italian Alps over a decade of wolf (*Canis lupus*) recolonization (2014–2023), surveying over 2,000 residents. Our stratified sampling captured the full gradient of recolonization phases, from areas where wolves had been absent for over a century to those with established populations exceeding twenty years. Using Bayesian ordinal regression, we modeled attitude and fear responses, testing how demographic, knowledge, and recolonization predictors varied across time and recolonization phase, and how attitudes, fear, and media coverage interrelate.
Contrary to expectations that opposition intensifies with wolf presence and time since recovery, we document a recolonization shock pattern: attitudes among rural residents are most negative during the initial wolf establishment (0–5 years), then gradually shift more positive despite continued wolf population growth. Human demographic effects were largely consistent with existing literature: women, younger persons, and those with higher education held more positive attitudes, as did those with greater knowledge of the species. Attitudes and fear were correlated, with more positive attitudes associated with lower fear of the species. However, fear also showed partial independence from general attitudes, with gender and the recolonization phase explaining much of this divergence, indicating that fear and attitude represent distinct constructs. Finally, rural attitudes were consistently more positive than sentiment expressed in online news coverage from the same years and areas, highlighting a divergence between media framing and local perceptions.
These findings demonstrate that attitudes toward returning carnivores are dynamic, context-dependent, and differentiated within rural communities. In particular, the observed comeback in acceptance following initial recolonization shock suggests that early-phase negativity, while intense and amplified in the media, may be temporary rather than enduring. For conservation practitioners, our results highlight the importance of recognizing the complex mosaic of attitude and fear drivers across demographic groups and recolonization stages, underscoring the need for tailored interventions in the communities where human-carnivore conflict is most acute.

Estimating the ecosystem services provided by the brown bear

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Brown bears (*Ursus arctos arctos*) play a critical ecological role in many ecosystems, delivering diverse ecosystem services (ES), including biodiversity support, nutrient cycling and ecotourism benefits. However, these services are often undervalued, complicating management strategies in contexts of human-wildlife conflict, in fact bear also causes damages to human activities. This study employs a bio-economic framework and discrete choice experiments (DCEs) to estimate the total economic value of brown bears in the Italian Alps, focusing on realistic attributes and levels informed by extensive stakeholder engagement.
A rigorous process of designing the DCE included focus groups, expert interviews, and pilot study to obtain a final survey across four countries (Italy, UK, France and Germany) administered to 2,500 respondents. Participants evaluated choice sets that varied bear-related attributes such as forest diversity, seed dispersal and berry availability, control of bee and wasp populations biodiversity, area conservation, public safety and economic costs, alongside socio-demographic factors. Analysis used a multinomial linear model implemented in the Apollo framework, in R. Results indicate a strong public valuation of ecosystem services provided by brown bears, with significant positive preferences forest biodiversity and services that enhance outdoor experiences rather than safety improvements. The findings also highlight the importance of public communication about these benefits, especially in regions facing local opposition to bear conservation like it is currently happening in Italy. Sensitivity analysis reveals heterogeneity in valuation across demographic and environmental attitudes, offering insights for targeted policymaking and it is not affected by income, indicating a wide ssocietal support for bear conservation. The Willingness to Pay for bear conservation was higher than reported in literature for wolf and lince in the same study area.
This research advances the methodological application of DCEs in large carnivore valuation by integrating ecological and socio-economic dimensions. Policy implications underscore the need for inclusive dialogue with stakeholders and the incorporation of ES valuation into wildlife management strategies. By quantifying the public's willingness to pay for bear conservation, this study provides insights for fostering coexistence between humans and large carnivores in the Italian Alps.

Wildlife Recovery Centres (WRCs): new partners for surveillance of emerging zoonotic pathogens

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Wildlife Recovery Centres (WRCs), reference structures for monitoring/assisting numerous wild and exotic species in trouble, including numerous mammal species, are heterogeneous entities at both the management and legislative levels. With appropriate guidelines, they can be effectively incorporated into early detection systems for emerging and re-emerging infectious agents with the aim of better identifying and managing potential health threats, representing a fundamental resource for monitoring infectious diseases and acting as epidemiological observatories of the territory. In fact, approximately two-thirds of emerging infectious zoonoses originate from wild animals, which can act as reservoirs of numerous infectious agents, viral and bacterial, diffusive and capable of infecting humans. For this reason, adequate surveillance programs and appropriate early detection systems are essential to minimize the consequences of their transmission and spread, containing their risks.
During the project, conducted between 2022 and 2024, site inspections were carried out in six selected WRCs in Piedmont, Liguria, and Valle d'Aosta. During the visits, organization, structure, and technical requirements were examined and a 30-question specific questionnaire was requested. At the same time, thanks to the collaboration of the territorial authorities, the Regional Veterinary Services and the IZSPLV staff, a Sampling Protocol was drawn up for Influenza A virus, West Nile and Usutu virus, Coronavirus and *Chlamydia* in the wildlife recovered in the Centres. Biomolecular investigations were performed at IZS PLV laboratories using standardized methods of RT Real-Time PCR for viral agents and Real-Time PCR for *Chlamydia*.
The evaluation of the survey retrieved important information on the data collection and exchange/collaboration with Research Institutions (University, IZS) and the communication flow between the Centres and local authorities, as well as the involvement of veterinary doctors and the awareness of the importance of early detection to manage possible health threats. During the sampling activity, with the cooperation of CeRMAS, samples were collected from wild animals through active monitoring (cloacal and/or oropharyngeal swabs on live/hospitalized animals) and passive monitoring (target organ samples from deceased or euthanized animals). Positivity for influenza A emerged only in Piedmont in 2023 (HPAI H5N1 and H13N2). *Chlamydia psittaci* was found in 2.6% of the samples, underlining the importance of surveillance of this zoonotic agent. Positive samples for WNV and USUV in October and November 2022 highlighted how a milder winter can influence the seasonal activity of insect vectors and prolong their viral transmission window. A coronavirus screening yielded 17 positives out of 285 bird samples taken. No positivity for influenza A and Chlamydia was found in carnivore samples in a parallel screening.
Wildlife Recovery Centres can be effectively incorporated into early detection systems for emerging and re-emerging infectious diseases to better identify and manage potential human health threats. Expanding knowledge on the risk of exposure to zoonotic infections is essential to strengthen prevention measures and mitigate potential risks to both animal and human populations, in order to work with a One Health approach.

SESSIONE 4.

Sentinelle d’alta quota: mammiferi ed ecosistemi montani

Functional importance of high-elevation Alpine lakes for bats

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Bats are known to occur at high elevations in mountain environments; however, their activity patterns in these areas remain poorly investigated. While water availability has been identified as a key factor influencing bat presence in mountain landscapes, the specific role of high-elevation lakes has received limited attention. Even fewer studies have simultaneously examined prey availability for European bats, represented by flying insects, in lake surroundings and the actual contribution of lakes to local insect supply. In this study, we tested the hypothesis that natural Alpine lakes represent ecological hotspots for bats at high elevations by providing both water and a locally enhanced supply of flying insects.
Ten natural Alpine lakes located between 2,090 and 2,805 m a.s.l. were selected within Gran Paradiso National Park, Italy. To test the effect of lakes on bat activity and prey availability, each lake was paired with a control site characterized by comparable environmental conditions and positioned at a similar elevation (±50 m) but at least 500 m away from the shoreline of the target lake and from any other lakes. Fieldwork was conducted during 2024 and 2025, with three monitoring sessions per year between July and September. At both lake and control sites, bat activity was monitored using an ultrasonic bat detector deployed for three consecutive nights during each sampling session. To quantify terrestrial flying insect availability, three sticky traps were installed at each site on 1.2 m poles positioned at 15 m from the bat detector. To quantify aquatic insect emergence, three floating emergence traps were positioned on the lake surface and anchored over a 50 cm water column to collect emerging insects. All insect traps operated continuously for approximately 72 h per session. Water and air temperature were recorded. Bat acoustic sequences were manually identified to species level using Kaleidoscope Lite, quantified as activity indices, and screened for feeding. Captured insects were identified, counted and measured. Individual body size data were subsequently converted to biomass using conversion coefficients. Ecological relationships were then investigated using Generalized Linear Mixed Models (GLMM) and Structural Equation Models (SEM) in R.
A total of 180 recording nights were acquired, resulting in 35,661 bat sequences, of which 3,832 were classified as feeding buzzes. Furthermore, 88 samples were collected from floating traps and 179 from sticky traps. Bat activity and feeding activity were both significantly higher at lake sites compared with paired control sites. Among environmental predictors, mean air temperature and elevation exerted significant but opposing effects on bat activity, bat and flying insect taxonomic richness, and flying insect biomass. The biomass of flying insects had a significant positive effect on bat activity, which in turn was positively associated with bat taxonomic richness. However, no significant difference was detected between lake and control sites in terms of flying insect biomass, as well as between the taxonomic richness of flying insects and bat activity.

These results demonstrate the considerable importance of natural Alpine lakes as foraging sites for bats. Although prey biomass did not differ significantly between lake and control sites, the influence of lakes appears to be indirect. Specifically, increased taxonomic diversity of prey has a direct positive effect on total prey biomass. This generates a cascading effect, positively influencing bat activity and, in turn, bat taxonomic richness. Our findings confirm that, even in alpine environments, bats behave as opportunistic foragers. Bat activity did not increase directly in response to higher prey diversity, but rather in response to greater prey availability. This increased activity translates into higher bat taxonomic richness, likely because bat species are attracted to sites offering greater food resources. These results highlight natural Alpine lakes as priority habitats for bat conservation and emphasizing the need to preserve lake ecosystems and their associated insect communities.

A requiem for Tina & Milo: Snow loss and prey mismatch threaten alpine stoats

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Climate change is profoundly reshaping mountain ecosystems, forcing cold-adapted species to shift upslope as suitable climatic conditions retreat to progressively higher elevations. These climate-driven range shifts can differentially affect predators and prey, disrupting their spatial overlap and potentially decoupling tightly linked interactions. Yet, the implications of such processes for predator–prey dynamics remain poorly understood. In this study, we investigated the effects of climate change on the stoat (*Mustela erminea*), a cold-adapted small carnivore whose seasonal white coat relies on persistent snow cover for camouflage, and on its specialized prey, the snow vole (*Chionomys nivalis*), in the Italian Alps. By jointly modelling the distributions of predator and prey, we aimed to assess future changes in habitat suitability, spatial overlap, and the potential emergence of climate-driven predator–prey mismatch under ongoing warming.
We collected geo-referenced occurrence records for both species between 2000 and 2024, integrating validated citizen science data, institutional databases, national and regional park reporting, museum collections, and targeted field surveys. Using an ensemble Species Distribution Modelling approach, we modelled current and future habitat suitability under a high-emission climate scenario (SSP5–8.5) to the year 2100. Models incorporated climatic, geomorphological, land-use, and biotic predictors, including snow cover duration and snow vole suitability, allowing us to explicitly account for both abiotic constraints and predator–prey interactions. Model performance was quantified through AUC and Boyce index, while projections were averaged across three modelling algorithms and five global circulation models. From binary projections, we quantified changes in range extent, spatial overlap between predator and prey, and shifts in range centroids along latitudinal and elevational gradients.
The models showed good predictive performance for both species (stoat: AUC = 0.77, Boyce index = 0.88; snow vole: AUC = 0.82, Boyce index = 0.68) and revealed divergent responses to future climate conditions. Snow vole habitat suitability was primarily driven by land-cover variables associated with rocky habitats and alpine grasslands, and projections indicated a substantial expansion of suitable habitat (+77%), particularly in northern sectors of the Alps. In contrast, stoat distribution was strongly influenced by snow cover duration and snow vole suitability, which together explained over 64% of model variance. Stoat habitat suitability showed a unimodal response to snow cover, peaking at intermediate values. Projections to 2100 indicated a severe contraction of the stoat's range (–36%), accompanied by an average upward shift of approximately 200 m and a northward displacement of its range centroid. Despite the predicted expansion of snow vole habitat, spatial overlap between predator and prey declined by approximately 35%, indicating a growing climate-driven mismatch.
Our findings demonstrate that climate change is likely to disrupt tightly linked trophic interactions in alpine environments through the combined effects of snow loss and spatial decoupling between predators and prey. For the stoat, reduced snow cover not only increases the risk of seasonal camouflage mismatch but may also limit access to its specialized prey. Although the species can exploit alternative prey, the snow vole represents a key resource in high-elevation habitats, and its decoupling from the predator is likely to exacerbate energetic constraints. Given the magnitude of the projected decline, our results suggest that the stoat—currently classified as Least Concern in Italy—may warrant reassessment under IUCN criteria, particularly as Vulnerable under Criterion A3c. More broadly, this study highlights the importance of jointly modelling interacting species to accurately forecast climate change impacts in mountain biodiversity, and underscores the need for long-term monitoring and targeted conservation actions for such species.

Sympatric *Lepus* spp. in the the central Italian Alps host significantly different gut microbiotas

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The mountain hare (*Lepus timidus*) is an arctic–alpine species with relictual populations in the Italian Alps, typically occurring above 2000 m a.s.l. It is threatened by habitat loss and fragmentation, as well as by the upward expansion of the European brown hare (*L. europaeus*), which may result in resource competition and loss of local adaptation through hybridization and interspecific gene flow. Gut microbiota diversity and composition play a key role in animal health and survival; therefore, investigating gut microbial communities in species exposed to rapid biotic and abiotic environmental changes may improve our understanding of their conservation status and extinction risk. However, the effects of sympatry on gut microbiota diversity and composition remain largely unexplored.
In this study, we compared the gut microbiota of the two hare species within a zone of overlap in the central Alps (Val Mazia/Matschertal, Italy) by analysing fresh faecal pellets collected along an elevational gradient (1000–2500 m a.s.l.). Species identity was confirmed using mtDNA barcoding, while gut microbiota was characterised through amplicon sequencing targeting prokaryotic 16S rRNA and fungal ITS2 marker genes.
Our results confirm the effectiveness of non-invasive sampling for monitoring gut microbial diversity and composition in elusive species such as *Lepus* spp. Distinct prokaryotic and fungal communities were detected for each species, even in areas where their distributions overlapped. Faecal samples of
L. europaeus were primarily dominated by Firmicutes and enriched in Bacteroidota and Spirochaetota, whereas *L. timidus* showed a predominance of Proteobacteria, followed by Bacteroidota and Acidobacteriota. Moreover, predicted functional profiles derived from taxonomic composition revealed differences in biosynthetic and metabolic potential between the host-associated microbiotas of the two species. Elevation influenced fungal, but not prokaryotic, diversity in both species.
Overall, our findings suggest that sympatry has so far had a limited impact on the gut microbiota composition of either species. In light of the expected upward range expansion of *L. europaeus* under climate warming and its continued restocking for hunting purposes, this study provides an important baseline for assessing the health and adaptability of *L. timidus*, as well as the effectiveness of conservation measures. Extending this research to additional areas of sympatry will be essential to determine whether gut microbiota composition can serve as an indicator of L. timidus conservation status across its range.

Population dymamics of the Apennine chamois in Abruzzo, Lazio and Molise National Park (ALMNP); insights from the last natural population

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The Apennine chamois (*Rupicapra pyrenaica ornata*) is an endemic mountain subspecies of high conservation value. It is listed in Annexes II and IV of the EU Habitats Directive (92/43/CEE), requiring strict protection and designation as a priority species, and it is classified as Vulnerable on the IUCN European Red List. Despite a numerical recovery following severe historical bottlenecks and intensive conservation actions, the subspecies still persists in a limited number of small and spatially isolated populations, with fewer than 2,000 mature individuals overall. Owing to their ecological specialization and sensitivity to environmental variation, Apennine chamois act as effective sentinels of environmental change, making the assessment of their population dynamics particularly relevant for conservation. The population of the Abruzzo, Lazio and Molise National Park (ALMNP) represents the only population that has undergone the full sequence of demographic phases, from a severe historical bottleneck to recovery and long-term persistence under natural regulation, offering a unique opportunity to examine intrinsic demographic processes and to predictions for other populations across the central Apennines. We analyzed long-term census data (block counts) collected from the 1970s to 2025, evaluating population dynamics at both large (overall Park area) and small scale (sub-areas of the Park, hereafter called "sectors"). Temporal dynamics were assessed to identify major change points, defined as shifts in population trends over time. Sector-specific vital rates were analyzed in relation to environmental and climatic variables using a Bayesian statistical framework, enabling the identification of key factors influencing population growth and stability. This approach allowed us to characterize both long-term population trends and spatial heterogeneity across sectors.

The overall ALMNP population exhibits a positive growth trend ($r = 0.017$, $\lambda = 1.018$; ~1.8% annual increase), although trends differ among sectors. At the population scale, we identified three major temporal change points, indicating non-linear dynamics characterized by alternating phases of increase and decline. At the sectoral level, these temporal change points are not evident and different areas showed completely different trends. For instance, the Val di Rose sector, historically central to chamois distribution, has experienced a marked decline exceeding 70% in the last 50 years, whereas the Marsicano sector shows strong and sustained growth increasing from 15 individuals in 2003 to more than 300 individuals in 2025. Additional heterogeneity is evident in demographic rates, for instance, natality (kids/total individuals) increased significantly over time in some sectors (e.g., Gravare: $\beta = 0.005$, $p = 0.028$), whereas other sectors exhibited weakly negative trends (e.g., Petroso: $\beta = -0.004$, $p = 0.057$).

These findings demonstrate that overall population dynamics emerge from the integration of divergent local trajectories, highlighting the value of fine-scale monitoring. The ALMNP population provides a reference system for understanding the natural demographic cycle of the species, allowing informed predictions for reintroduced populations elsewhere in the Apennines. By considering together population trends, vital rates, and environmental variables at different spatial scale, this study identifies key drivers of population growth and stability and underscores the role of mountain mammals as sentinels of environmental change, offering guidance for adaptive management strategies for this high conservation value species.

Population dynamics and body condition of snow voles in the Alps and Apennines: towards a long-term monitoring network in response to climate change

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The snow vole (*Chionomys nivalis*) is a cricetid rodent characterized by a fragmented distribution across southern Europe. In Italy, it mainly inhabits screes along the Alpine and Apennine chains. Due to its specialized ecology and dependence on mountain environments that are highly sensitive to thermal variations and snow cover, the snow vole is considered a key sentinel species for monitoring climate change effects in high-altitude ecosystems. Since 2014, long-term monitoring has been conducted in the Gran Paradiso National Park (Western Alps) and has recently been expanded to Gran Sasso and Monti della Laga National Park (Central Apennines) and Alpi Marittime Natural Park (Western Alps), thereby establishing a research network aimed at comparing populations across different biogeographical contexts.
Population dynamics were investigated using Bayesian Dynamic Occupancy Models applied to live-trapping data collected in two summer sessions (July/early August and late August/September) with Sherman traps. Inter-annual dynamics were investigated for one grid in Gran Paradiso (2014-2025), while in Gran Sasso and Alpi Marittime, where activities began in 2025 with two and three grids respectively, intra-seasonal dynamics and grid comparisons were prioritised. In parallel, body condition was evaluated for adult, non-reproductive individuals at first capture using the Scaled Mass Index (SMI) and compared among populations.
Occupancy models revealed evidence of active recolonization. In Gran Sasso (GS), estimated occupancy ($\hat{\psi}$) remained high in $Grid_{GS}1$ (0.65 to 0.60), and increased in $Grid_{GS}2$ (0.37 to 0.46), where a high colonization probability ($\hat{\gamma}$ = 0.47) facilitated recovery following an initial phase of low occupancy. In Alpi Marittime (AM), $Grid_{AM}1$ showed the greatest stability and highest occupancy (0.77 to 0.80), while $Grid_{AM}3$ exhibited the most meaningful recovery, with occupancy increasing from 0.10 to 0.30. In Gran Paradiso (GP), detection probability was influenced by mean temperature and precipitation, and occupancy dynamics were highly variable. Occupancy peaked in 2017 ($\hat{\psi}$ = 0.85), declined sharply in 2019 and 2024 ($\hat{\psi}$ = 0.24), and only partially recovered in 2025 ($\hat{\psi}$ = 0.45). Initial occupancy was primarily driven by physical habitat variables, such as rock size and slope. Colonization probability was positively associated with high NDVI in the previous season and mild winter temperatures, whereas extinction probability was mitigated by higher winter temperatures and deep snow cover, which ensures sub-nivean insulation. Linear modelling of globally standardized SMI revealed significant spatial variation in body condition ($F_{2,99}$ = 14.2, $p < 0.00001$): Gran Paradiso individuals showed better condition than those of Gran Sasso (1.02 SD, $p < 0.0001$) and Alpi Marittime (0.65 SD, p = 0.046), while Alpi Marittime and Gran Sasso did not differ.
The time series from Gran Paradiso confirms the species' preference for steep, rocky terrains and indicate that population stability is largely driven by winter conditions regulating survival, while colonization is influenced by summer primary productivity. The SMI results provide preliminary evidence of spatial differences in body condition among populations. Notably, the marked contrast between stable and highly dynamic grids within both Gran Sasso and Alpi Marittime highlights the importance of multi-site monitoring to capture local demographic heterogeneity. The establishment of this long-term monitoring network across the Alps and Apennines therefore represent a crucial step toward understanding the resilience of this sentinel species. By integrating data from diverse biogeographical contexts, it will enable more accurate predictions of biological responses in high-altitude ecosystems to the growing pressures imposed by global climate change.

Spatio-temporal interactions between roe deer and red deer in the Alpine environment: the role of temperature and wolf

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Interactions between sympatric ungulates are shaped by both biotic factors, such as interspecific competition for space and food or predator presence, and abiotic environmental conditions, including habitat features and dynamic components such as temperature. However, the mechanisms through which these drivers simultaneously modulate space and time use of sympatric ungulates remain complex and difficult to disentangle, particularly in Alpine ecosystems currently experiencing rapid climate change and recent wolf recolonization. This study investigates the relationships between roe deer *Capreolus capreolus* and red deer *Cervus elaphus* in two ecologically similar areas of the Lombardy sector of the Stelvio National Park, located in the municipalities of Valfurva (SO) and Ponte di Legno (BS), which differ in wolf occurrence. The aim is to assess how local temperature variability and predator presence influence roe deer space-time use and its interaction with red deer. Data derive from a camera-trapping monitoring program conducted during the summer months from 2020 to 2024. Local temperatures were recorded using sensors installed at each sampling site, with measurements taken every two hours. Space use was analysed through generalized linear mixed models with a negative binomial distribution, using daily roe deer detection rate as the response variable and including environmental and detection covariates together with the within–between variance decomposition of red deer trapping rate and daily maximum temperature to distinguish within-site temporal variation from between-site average differences across areas with and without wolves. Preliminary analyses suggest that roe deer activity is associated with both local variability in red deer activity and thermal conditions, with effects differing between spatial and temporal components. Patterns consistent with behavioural modulation potentially linked to wolf presence also emerge, although further investigation is required for robust interpretation. Overall, this framework highlights the importance of jointly considering biotic and abiotic drivers while integrating spatio- temporal scales to better understand behavioural plasticity in Alpine ungulates. These insights contribute to interpreting mammal community responses to ongoing environmental change and may help guide conservation and management strategies in mountain ecosystems.

Insights on the effects of the Vaia storm on mammal communities in Alpine forests

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Windstorms are currently the main source of abiotic disturbance in European forests and climate change is increasing their frequency and intensity. Changes in windstorms' regime can impair forest dynamics, and affect fauna-forest interactions, undermining the resilience of these ecosystems. In 2018 the Vaia windstorm hit the eastern Alps, destroying thousands of hectares of woods in just two days and drastically changing mountain landscapes. Given the crucial roles mammals play in forest dynamics and regeneration, this project aims to assess the impact of the Vaia storm on mammal communities and on wildlife–forest interactions seven years after the event.

Combining live trapping of rodents with camera-trapping of medium and large mammals, we studied space use of multiple species in relation to a gradient of storm impact, in the Altopiano di Piné (Trento province, north-eastern Alps), during spring and late summer 2025. To assess mammal-forest interactions under different levels of storm impact, we also conducted vegetation surveys, thereby assessing the responses in the composition and structure of the tree and shrub layers and detecting potential browsing damage in forest regeneration. We deployed 54 camera-traps equally distributed between three levels of storm impact (low, medium, high), following a systematic grid and with a random placement. Of these, 30 camera traps (10 for each level of storm impact) were spatially associated to a 100m live-trapping transect, each including 10, equally spaced, traps. For each small mammal captured we identified the species, sex, reproductive state and weight. We also marked them with an individual haircut to distinguish among individuals in subsequent captures.

We found that the species detected through camera-trapping were the same across the three levels of impact however their relative detection frequency varied. In the high impacted sites, site-level species richness was significantly lower and most of the recorded species had a lower detection frequency. Also the number of individual bank voles captured was significantly lower in high-impact transects, whereas *Apodemus* spp. did not show marked differences. Furthermore, for most species the level of impact was a relevant predictor in the modelling of both the camera-trapping detections and the number of live-captured individuals.

Our results show that the habitat use of most mammalian species detected seems to be affected by the level of impact of Vaia storm, with a lower preference for the highly impacted sites. Further analyses that include the vegetation data will help clarify the dynamics and variation of wildlife-forest interactions across storm impact levels. These findings are highly relevant in light of the projected increase of windstorm impact on temperate forests and mountain ecosystems as the climate crisis worsens.

Cross-continental insights into montane ecosystem change: linking evolutionary space-use strategies and population dynamics in tree squirrels

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Mountain forest ecosystems are characterized by strong climatic constraints and pronounced temporal variability in resource availability, making them particularly sensitive to climate change and disturbance. Mammals inhabiting these systems often exhibit specialized space-use strategies shaped by long-term adaptation to local resource phenology and habitat structure. In montane conifer forests, the timing and predictability of cone production and seed release have played a central role in the evolution of contrasting foraging and territorial strategies among tree squirrels. Integrating this evolutionary context with contemporary ecological dynamics is essential to understand how mountain mammals respond to ongoing environmental change and to assess their role as sentinels of ecosystem transformation.
We synthesized long-term studies on two tree squirrel species occupying montane and subalpine conifer forests on two continents: the Eurasian red squirrel (ERS, *Sciurus vulgaris*) in the Central Italian Alps and Fremont's squirrel (FS, *Tamiasciurus fremonti*) in the mountain ranges of southeastern Arizona, USA. These systems differ in disturbance regimes, and in conifer cone phenology. In AZ montane forests, cones typically mature and open over short time windows, favoring early cone harvesting, larder-hoarding behavior. In contrast, European montane forests exhibit more gradual cone opening and prolonged seed availability, promoting scatter-hoarding strategies. Spatial ecology (ERS: 139 individuals, FS: 720) was quantified using telemetry and home-range analyses to characterize species-specific patterns of space use and territoriality in relation to forest structure and resource distribution. Population dynamics were assessed through long-term density estimates obtained via capture–mark–recapture for ERS (years 1999- 2019) and midden-based indices for FS (years 1993- 2018). Environmental drivers included field-based measures of forest composition and seed production, seasonal climatic variables, and remotely sensed indicators of vegetation condition and forest disturbance. Time-series and multivariate modelling approaches were used to disentangle density-dependent processes from exogenous climatic and habitat-related drivers and to link space-use strategies with demographic responses.
Despite marked differences in space-use strategies shaped by evolutionary adaptation to regional resource phenology (smaller midden-centered home ranges affected by seasonality for FS and larger overlapping home ranges for ERS), both squirrel species exhibited population dynamics primarily driven by bottom-up processes. Interannual variation in conifer seed availability and spring temperature consistently explained fluctuations in population density across both montane systems, highlighting the sensitivity of tree squirrels to trophic pulses and short-term climatic variability. However, the strength and structure of these responses differed between species (annual oscillation of population size in FS and biennial oscillation in ERS). The strongly territorial *T. fremonti*, reliant on defended food caches within small, exclusive territories, showed heightened sensitivity to localized habitat alteration and forest

disturbance, particularly in systems affected by climate-driven drought, fire, and insect outbreaks. In contrast, the non-territorial *S. vulgaris*, characterized by larger and overlapping home ranges, exhibited demographic responses buffered by greater spatial plasticity and access to heterogeneous resources. Although both species responded to similar environmental drivers, demographic trajectories were weakly synchronized across sites, emphasizing the role of local habitat context and disturbance regimes in modulating species-level responses. By explicitly linking evolutionary adaptations in space use with long-term population dynamics, this integrated cross-continental framework demonstrates how montane mammals function as effective sentinels of environmental change and provides insights relevant to conservation and management of mountain forest ecosystems.

Using animal-borne proximity loggers to estimate home range in a wild-living small mammal

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The home range is one of the most commonly used metrics in movement ecology for quantifying the area travelled by an individual during its daily activities. GPS (Global Positioning System) technology represents the state-of-the-art tool in movement ecology. Nevertheless, some species remain unsuitable for GPS tracking because of their small body size or physical characteristics that prevent the safe deployment of tracking devices. In such cases, movement data can be obtained through direct visual observations, which, however, are limited to diurnal species living in visually accessible areas and ideally require confirmation by more robust methods. Proximity loggers are compact, animal-borne transceiver devices based on wireless sensor network (WSN) technology that offer a viable alternative to GPS for tracking individual locations. When two tagged animals move within the detection range of a stationary logger, or each other's detection range, the devices communicate and record the encounter in onboard memory. In this study, we assess the agreement between home-range estimates derived from visual observations and from animal-borne proximity loggers in a population of Alpine marmot *Marmota marmota*.
The study was conducted in the summer season of 2024 in Stelvio National Park. Eleven individuals were captured, sexed, aged, marked with colored ear tags, and equipped with a proximity logger glued at the base of the tail. The study area was discretized into a hypothetical 10×10 m grid, and each grid cell was assigned a centroid-based ID. Each day, eight grid cells were randomly assigned a stationary logger, positioned at the centroid of the cell, following a randomized schedule that ensured that all 164 grid cells were sampled at least once over the study period. Concurrently, visual observations were conducted on a daily basis, during the species' active period, using a 15-minute focal animal sampling, with individual locations recorded at one-minute intervals and assigned to the corresponding grid centroid. For both methods, multiple detections within the same grid cell were collapsed to the centroid-based ID, so that each cell contributed equally regardless of detection frequency. Home range sizes were estimated using the 95% Minimum Convex Polygon (MCP) method. Agreement between approaches was assessed using a Bland-Altman analysis, a robust log- log regression, and a spatial overlap analysis.
Home range estimates from proximity loggers (0.86 $\pm$ 0.15 ha) were slightly larger than those from visual observations (0.79 $\pm$ 0.22 ha), with good overall agreement between methods (bias = −0.07 ha). The robust log-log regression showed a positive significant relationship between the two estimates ($\beta = 0.84$, $t = 2.48$, $p \approx 0.035$). Home ranges derived from visual observations overlapped with those obtained from proximity loggers by an average of 87.5% (SD $\pm$ 12.7%), indicating substantial spatial concordance between the two methodologies.
Observation-based and proximity logger-based home ranges therefore showed good overall concordance. Both approaches have inherent limitations. Proximity logger estimates may be influenced by the spatial arrangement of detectors, while observation-based estimates may be more uncertain due to the smaller number of recorded locations. The overall agreement between the two metrics, however, suggests that direct observations may provide meaningful insights into the spatial ecology of Alpine marmots. Direct observations may offer a valuable tool for studying free-living species in open, researcher-accessible habitats when GPS tagging is not feasible.

Optimal Monitoring of Mammals in Alpine Environments: Development of Multi-species Protocols and Assessment of the Umbrella Effect

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Wildlife monitoring is a fundamental tool for biodiversity management and conservation, but it requires statistically robust protocols capable of detecting population declines while remaining cost- effective. Monitoring mammals is particularly challenging due to their low detectability. Although numerous studies have focused on developing monitoring protocols for mammals, including camera- trap–based approaches, most existing protocols (i) are not explicitly designed to detect population declines (i.e. their statistical power has not been evaluated), (ii) fail to account for logistical constraints such as economic costs and site accessibility, and (iii) focus on a limited number of species. We address these three limitations by developing statistically robust monitoring protocols that explicitly incorporate budgetary constraints and site accessibility, and by testing a recently proposed framework for applying monitoring protocols to multiple species. Specifically, the concept of *umbrella species for monitoring* has been introduced as a promising strategy to improve monitoring efficiency by enabling the simultaneous monitoring of multiple species. However, alpine environments pose additional challenges, as altitudinal gradients harbour suites of species with contrasting habitat requirements and are often characterized by limited accessibility. Consequently, an empirical assessment of the extent and conditions under which a monitoring umbrella effect can be achieved in alpine systems is still lacking.
Here, we present the results of the MOM-PG project (Optimal Monitoring of Mammals in the Julian Prealps), which aimed to develop a multi-species monitoring framework with the dual objective of identifying optimal monitoring protocols and evaluating the applicability of the umbrella monitoring species concept in an alpine context. Field activities were conducted over two seasons (2024 and 2025) using an integrated approach that combined camera trapping for medium- and large-sized mammals, live trapping of terrestrial small mammals, and the use of nest tubes to monitor the hazel dormouse (*Muscardinus avellanarius*). The sampling design was stratified by habitat type and implemented across 104 transects—64 of which were also used for small-mammal live trapping— spanning an altitudinal gradient from valley bottoms to high-altitude alpine grasslands, in addition to 80 transects dedicated to dormouse monitoring. Collected data were analysed using multi-season occupancy models to estimate species occurrence and detection probabilities while accounting for imperfect detectability. These models were combined with power analysis to determine the sampling effort required to detect different levels of decline (10%, 25%, and 50%) in the occupancy of target species. Overall, camera trapping yielded 5,289 trap-nights and resulted in the detection of 18 mammal species, including carnivores such as the golden jackal and wildcat, ungulates such as red deer and wild boar and rodents such as the red squirrel and fat dormouse. Analyses revealed high detectability for several ungulate and carnivore species, allowing the development of monitoring protocols capable of detecting moderate declines in occupancy with relatively limited sampling effort.
We further evaluated multiple budget scenarios (€10,000–50,000), identifying the monitoring objectives that are feasible under different financial constraints. Our results indicate that, in alpine environments, optimal monitoring performance can be achieved by identifying a complementary suite of umbrella species that collectively span the entire altitudinal gradient. Our findings demonstrate that integrating occupancy modelling with power analysis enables the design of efficient monitoring programs that can be tailored to different budgetary and logistical constraints. To our knowledge, this project represents the first empirical application in Europe of the concepts of optimal monitoring and monitoring umbrella species, providing a practical framework for conservation managers and contributing to the development of evidence-based, quantitative, and replicable conservation strategies

Poster

N. 1

Recolonization and demographic dynamics of the wolf (*Canis lupus italicus*) in the coastal area of Rome

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The return of the wolf (*Canis lupus italicus*) to lowland and peri-urban areas represents an event of major biological and social significance.
From 2020 to 2025, we monitored the dynamics of wolf presence within the Litorale Romano Natural Reserve, a protected area of 15,900 ha located west of Rome. Monitoring focused on pack number and composition, genetic characterization, reproductive rates, and causes of mortality. From October 2023 to December 2025, monitoring activities were carried out in collaboration with the Istituto di Ecologia Applicata (IEA) and Sapienza University of Rome, within the framework of replication activities of the EU-funded LIFE Wild Wolf project. Data collection relied on an integrated monitoring approach combining three techniques: (1) camera trapping, (2) non-invasive genetic sampling and (3) wolf howling. Biological sampling and camera traps placement followed an opportunistic protocol. Wolf howling surveys were conducted opportunistically between August and November, only in cases where pack reproduction had not been previously confirmed through camera trapping.
Between 2020 and 2025, the number of reproductive packs increased significantly. The first pack, documented since 2017, occupies a stable territory partially overlapping the Oasi Lipu Castel di Guido (CDG pack). In 2021, the first reproduction of a second pack was confirmed in the area between Maccarese and Aranova (BDL pack), which was detected until spring 2024. Following the death of the breeding male (autumn 2023) and the breeding female (spring 2024), the pack was no longer recorded. In autumn 2023, the formation of a new breeding pair was detected in the area between Fregene and Maccarese. This pair reproduced for the first time in spring 2024 (FRG pack). Since 2024, the reproduction of an additional pack have been confirmed in the north-eastern sector of the Reserve, between Testa di Lepre and Aranova (TDL pack).
The CDG pack reproduced every year from 2021 to 2025, with litter sizes ranging from a minimum of four pups (2023) to a maximum of eight pups (2022). The BDL pack reproduced in 2021 and 2022, with litter sizes of four and five pups, respectively. The FRG pack reproduced in 2024 and 2025, producing litters of seven and eight pups, respectively. The TDL pack reproduced in 2024 and 2025, with at least three and two pups recorded, respectively, in late autumn.
From October 2023 to April 2025, non-invasive genetic sampling allowed the identification of a total of 16 individual genotypes (9 males and 7 females). ISPRA used 12 microsatellite markers to generate individual multilocus genotypes and to assign each sampled animal to one of the following categories:

(1) non-admixed wolf, (2) recent wolf-dog hybrid, or (3) non-recent introgressed individual. Ten individuals (62.5%) were classified as non-admixed wolves, four individuals (25%) as non-recent introgressed wolves, and two individuals (12.5%) were classified as recent wolf-dog hybrids.
During the study period (2021–2025), eight wolf carcasses were recovered. Road collisions were the cause of mortality in six cases (75%), illegal killing by firearm in one case (12.5%), and natural disease in one case (12.5%).
Overall, the data indicate a significant positive population trend in the study area, with an increase in reproductive packs, consistent with the wolf population trend at the national scale. Current monitoring has confirmed the presence of at least three reproductive units within the central-northern portion of the Reserve. The main challenge in the coming years will be to promote the coexistence of a stable and viable wolf population with human activities in a peri-urban landscape and to ensure that any negative interaction with humans is avoided.

N. 2

Increasing proximity between wolves and humans in Italy: an evidence-based management protocol

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The number of wolves (*Canis lupus*) in Italy has increased significantly in recent decades, passing from about one hundred in the ,70s to the current estimated over 3500 individuals. This has been primarily due to land-use changes, protection policies, conflict mitigation measures and increased public acceptance, together with the species' high plasticity, which has allowed the wolf to expand its distribution range and to colonize very diverse habitats, including agricultural land, coasts, and urbanised areas. Consequently, an increase in the number of interactions with people is being recorded, often associated to social alarm in many areas of the country. ISPRA is the scientific environmental authority in charge of monitoring wildlife in Italy, and under the national legal framework shall provide a technical evaluation for all interventions regarding wolves, including trapping, aversion techniques, translocations and removals. Also, especially in the last decade, mayors and prefects regularly request ISPRA to provide technical support for the management of wolves posing risks to humans.
Therefore, during the period 2016–2025, through interactions with public administrations, ISPRA collected a lot of data on social alarm situations due to wolf presence in urban environments and/or on interactions between wolves and humans (e.g. the presence of potential attractants), including attacks and other dangerous interactions, as well as information on all the management measures implemented and the outcomes on such interventions.
In total, over 100 social alarm situations were recorded in a dedicated database; out of them, more than 50% occurred in the 2023-2025 period only, highlighting an increase of the number of cases in recent years. A total of 9 different wolves were responsible for 20 attacks. The management measures undertaken included aversion techniques (7 cases), release in a nearby natural area with a radio-collar (2 cases), translocations to remote natural areas (2 cases) and captures of individuals for permanent captivity (5 cases). No wolf involved in such situations has been killed in Italy, so far. Based on an in depths analysis of all the data described above, ISPRA developed a technical protocol that categorises all recorded behaviours, based on a scale of increasing risk to humans, classified into 5 levels, from negligible risk to high risk. For each behaviour, the protocol describes a set of possible response measures, ranging from intensive monitoring to the removal of attractants, implementation of aversion techniques, translocation of individuals and removal of dangerous animals. The measures are defined considering the recurrence of behaviours, which is essential for risk classification. The actions set out in the protocol are characterized by a gradual impact on individuals of the species, proportional to the estimated risk to public safety. The protocol is built upon the 2019 LCIE protocol, integrating it to provide a more detailed guidance to public administrations. It was officially presented in 2025 to all Italian regions and autonomous provinces, in a meeting co-organised by the Ministers of Environment and Agriculture, and it is therefore a formal support to decision-making at the national level.
The overall goal of the protocol is to enhance coexistence between humans and wolves, minimising risks to humans and ensuring an evidence-based, proportionate management of all interactions between wolves and humans, aligned with the national and EU legal frameworks.
The protocol was developed within the Life program LIFE21/NAT/IT/101074417- LIFE Wild Wolf "Concrete actions for maintaining wolves wild in anthropogenic landscapes of Europe".

N. 3

Anthropogenic pressure on Carnivore Occupancy Patterns in Madagascar

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In countries such as Madagascar, where rapid human population growth and persistent socio-economic challenges intensify pressure on natural resources, understanding the effects of anthropogenic disturbance on wildlife has become a critical conservation priority. In particular, deforestation and habitat degradation, including the introduction of invasive species and human persecution are considered to be the major threats faced by the Malagasy carnivore. Despite their ecological importance role as predators, little is known on their distribution, habitat selection, interspecific interaction and disturbance tolerance. By applying multi-species occupancy model, our study aims to investigate (1) how the anthropogenic and environmental variables can affect the carnivore distribution patterns (2) whether human-induced habitat alteration affects species co- occurrence, potentially promoting spatial cohesion or avoidance among carnivores. In Maromizaha New Protected Area, a primary forest in eastern Madagascar, we set 44 camera traps on a spatial grid system of 100m cells, between March and June 2025 and we documented the simultaneal presents of fossa (*Cryptoprocta ferox*), and other 4 carnivore such as the spotted fanaloka (*Fossa fossana*), falanouc (*Eupleres goudotii*), ring-tailed vontsira (*Galidia elegans*), broad-striped vontsira (*Galidictis fasciata*). Our results indicate that anthropogenic disturbance influenced carnivore occupancy, with both the fossa and other carnivores preferentially occurring in areas farther from human settlements and characterized by lower habitat degradation. However, anthropogenic pressure did not appear to enhance either spatial cohesion or avoidance among carnivores, despite their overlapping presence. Overall, our findings highlight their sensitivity to human presence and emphasize the importance of developing conservation strategies that mitigate human–carnivore conflict, by promoting the persistence of endemic carnivores in their natural habitats and the ecological integrity of Madagascar's forest ecosystems.

N. 4

Wolf-prey interactions in a protected area in the Tuscan Apennine

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Predator-prey interactions are among the primary drivers of community composition and dynamics, as they can affect species distributions and abundances through top-down or bottom-up control. Prey species often modify their spatial and temporal behaviour in response to predation risk, while predators can follow the distribution of preferred prey. In recent decades, the Apennine wolf (Canis lupus italicus) has increased its numbers across the Italian peninsula, demonstrating strong ecological adaptability in both habitat and prey selection. Its diet has been shown to be varied, mostly comprising wild ungulates when their abundance is high; in this work, we investigated how prey selection can affect the spatial and temporal use of a protected area by the local community.

We conducted a year-long study in a protected area in the Tuscan Apennines (Oasi Dynamo), where a wolf pack has established a core territory for the past few years. We investigated their relationship with the local community, focusing on potential prey (wild boar, red deer, roe deer, fallow deer, and mouflon) and competitors (red fox). Images from 36 camera traps were analysed to derive density estimates for the species of interest using the Random Encounter Model (REM). Subsequently, we used different statistical approaches, including the Generalised Linear Mixed Model (GLMM) and the Integrated Nested Laplace Approximations (INLA), to obtain a picture of the spatial and temporal relationships between the target species, focusing on the effect of prey in wolf site selection and on predator avoidance by the other species.

We observed substantial variability in the capacity to predict the presence of wolves based on prey species. Predator avoidance also differed by focus species, reflecting varying vulnerabilities to wolf predation; the most vulnerable species tended to select areas less frequented by wolves and to avoid revisiting after wolf detection in the previous three or seven days. On the contrary, foxes were positively associated with wolves, strongly supporting their scavenging role of wolves' prey residuals.

Understanding species' spatial habits and their effects on the community is key to evaluating their role in the ecosystem. As shown here, species can influence each other's site selection both positively and negatively, shaping spatial use in areas of sympatry.

N. 5

Sex allocation in red deer Cervus elaphus: Testing maternal effects across contrasting environments

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The mechanisms underlying adaptive modulation of offspring sex ratio at birth in mammals remain debated, and empirical evidence is often heterogeneous, depending on ecological and methodological contexts. Several evolutionary hypotheses, including the Trivers–Willard hypothesis, local resource competition, paternal quality, and the energetic cost hypothesis, aim to identify proximate factors driving biases in sex allocation. This study tests whether and how maternal condition influences sex allocation at birth in red deer *Cervus elaphus* across contrasting environmental contexts.
We considered three populations differing in environmental characteristics: two Alpine populations within the Stelvio National Park, and one Apennine population in the Province of Pistoia. Data were collected during the regular culling seasons over 21 years for the Alpine populations and 15 years for the Apennine population. In total, we analysed data of 1,030 female individuals. Only female deer with complete information on fetal sex, age, body mass, jaw length, kidney fat reserves, and lactation status were included in the analysis. For each population, female status was assessed using multiple complementary indices to capture both short-term energetic conditions (Kidney Fat Index - KFI, and Body Condition Index - BCI) and longer-term structural investment (age and lactation status). KFI was measured as the ratio between perirenal fat weight and kidney weight, while BCI was calculated as the residuals of the model relating body mass and jaw length corrected for age. Age was estimated by counting tooth cementum annuli and lactation status assessed through milk presence or udder incision. The three study populations were analysed independently from one another. Maternal influences on fetal sex were investigated using piecewise structural equation models (pSEM), allowing estimation of direct effects of maternal traits (age, KFI, BCI, and lactation status) on fetal sex, as well as indirect and mediator effects via causal pathways. Effects were quantified as semipartial correlations, with 5,000 bootstrap iterations providing standardized estimates and confidence intervals. Model fit was assessed using Fisher's C statistic and directed separation (dSep) tests.
Results indicate that variation in offspring sex ratio at birth across populations was not consistently associated with the variables considered. Across all populations, kidney fat index and lactation status showed no consistent effect, suggesting that neither energetic condition nor reproductive state consistently influence fetal sex. In contrast, age and body condition showed weak but population-specific patterns. Age effects were quadratic and negative in the Alpine populations, with prime-aged females producing relatively more males, whereas no clear age-related pattern emerged in the Apennine population. This indicates that age-related sex allocation is context-dependent, likely reflecting differences among populations in the fitness payoffs of producing sons versus daughters. Similarly, BCI showed weak and opposing trends among populations, consistent with its role as a context-dependent proxy of maternal quality. The explained variance across different models was low (3-5%). These results do not imply lack of biological signal, but rather that: i) possible adaptive adjustment is subtle, ii) many factors remain unmeasured, iii) sex-allocation has a probabilistic nature, iv) selection at the individual level may be weak and it may be easily masked by noise. This suggests that sex allocation in red deer is not governed by a single universal condition-based rule, but rather that it is contingent on ecological context, highlighting the complexity of the mechanisms shaping sex ratios.

N. 6

The Alpine Mostela: a promising camera-trap system for investigating predator- prey dynamics at high altitudes

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The stoat (*Mustela erminea*) is a small mustelid inhabiting the Italian Alps, where it acts as a specialized predator of the snow vole (*Chionomys nivalis*). Despite this tight ecological relationship, predator-prey dynamics in alpine ecosystems remain poorly understood, largely due to their cryptic behaviour and the logistical constraints of conducting fieldwork at high elevations. The Alpine Mostela, an enclosed camera trap specifically designed to monitor stoats and other elusive small mammals, offers a promising tool to overcome such limitations. However, its effectiveness in capturing predator-prey interactions has yet to be formally evaluated. This study aims to evaluate the performance of the Alpine Mostela in detecting stoats and snow voles by comparing its outputs with data obtained from external camera traps and live-trapping, and to assess its potential for describing small mammal communities in high altitude environments. Fieldwork was conducted from June to October 2025 in the Alpi Marittime Natural Park (south-western Alps), across three sub-areas located at 1800 m (A), 2100 m (B), and 2400 m a.s.l. (C) respectively. In each area, four Alpine Mostelas and four external camera traps were deployed at paired stations spaced approximately 250 m apart, with external cameras oriented toward the Mostelas. Monthly live trapping sessions targeting small mammals were carried out using 50 Sherman traps per each sub-area arranged at a 10 m intervals. Method performance was compared using maximum likelihood occupancy model to evaluate differences in detection probability among survey techniques. Daily and seasonal activity patterns of stoats and snow voles were also analysed to identify periods of increased detectability. Finally, small-mammal community composition inferred from cameratrap data was compared with that obtained from live trapping. A total of 2,375 camera-trap days yielded 454 video recordings of stoats and small mammals. Alpine Mostelas detected stoats more frequently than external cameras (66 vs. 26) and recorded substantially higher numbers of snow voles (228 vs. 25). Detection probability for stoats was low across both methods, but slightly higher for Alpine Mostelas ($p = 0.05$, 95% CI 0.04–0.08) than for external cameras ($p = 0.03$, 95% CI 0.02–0.05). For snow voles, detectability was highest with Alpine Mostelas ($p = 0.11$, 95% CI 0.10–0.13) and lowest with external cameras ($p = 0.05$, 95% CI 0.03– 0.09). Stoats showed a predominantly diurnal activity pattern, whereas snow voles were mainly nocturnal; temporal overlap between the two species was moderate ($\Delta_4 = 0.25$, 95% CI 0.20–0.41). Seasonally, stoat detectability increased from August onwards, while snow vole activity varied throughout the sampling period without a clear trend. At the community level, Alpine Mostelas detected seven small mammal species, compared with five species recorded through live trapping.Overall, the Alpine Mostela proved to be the most effective method for detecting stoats, snow voles, and other small mammal species at high elevations. However, the substantial overlap in confidence intervals among methods indicate persistent uncertainty in detectability estimates. In particular, reliance on the Mostela alone may result in incomplete assessments of stoat occurrence, which can be improved by integrating data fromexternal camera traps. Moreover, although Alpine Mostela allows longer sampling periods and broader spatial coverage, it cannot provide key biological information obtainaible only through capture-based methods. While the combined use of Alpine Mostelas and complementary survey methods is therefore recommended for targeted ecological studies, Alpine Mostela alone represents a practical and effective tool for long-term monitoring of these species in alpine environments.

N. 7

Living Labs as an integrative approach to human–large carnivore coexistence: the 4PETHABECO experience

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Coexistence between humans and large carnivores (LCs) represents a complex socio-ecological challenge determined by ecological dynamics, socio-cultural and economic factors, and governance frameworks. Addressing this complexity requires integrative and participatory approaches that foster dialogue between scientific knowledge, traditional practices and empirical, experience-based knowledge. Such interaction motivates the co-development of socially acceptable solutions that respond to the diverse interests and needs of both human and non-human communities within specific socio-ecological systems.
Living Labs (LLs) are *user-centred, open innovation ecosystems based on a systematic co-creation approach, integrating research and innovation processes in real-life communities and settings*. Although mainly applied in other fields so far, LLs can prove to be a promising approach to promote sustainable coexistence between LCs and human activities. By actively involving end-users and stakeholders throughout the co-design, testing and validation phases, LLs respond to practical needs and local priorities, increasing the relevance, desirability and potential adoption of proposed innovations. The integration of multiple perspectives enhances problem-solving capacities, fosters cross-sectoral collaboration and contributes to the development of more robust, adaptable and socially accepted solutions. Furthermore, real-life experimentation combined with iterative evaluation strengthens the validity and reliability of outcomes, enabling early identification of risks and providing solid evidence base for real-world applicability.
The LL methodology is applied within the Interreg IPA ADRION 4PETHABECO project, whose aim is to promote the sustainable management of LC habitats and populations, and to enhance coexistence across the Adriatic–Ionian region. A network of LLs focusing on several key sectors dealing with LCs, including farming, hunting, ecotourism, education and policy-making, is established in the region. In Friuli Venezia Giulia, Italy, a local LL focuses on conflicts between LCs and livestock-related activities. Multiple relevant stakeholders are engaged through participatory processes and real-life experimentation to co-develop innovative, sustainable and locally adapted strategies to reduce the impact of LCs on livestock-related activities, balancing conservation objectives with the socio-economic sustainability of rural communities. In particular, this LL tests a range of livestock management and damage prevention measures, including the use of GPS collars equipped with accelerometers on guardian dogs and livestock. In addition, a dedicated chat system is being implemented to enable rapid and direct interaction among farmers, researchers, local LC managers and other relevant stakeholders. This tool facilitates timely information exchange to support livestock management while simultaneously providing valuable data for LC monitoring. The methodological approach and first, preliminary results are presented.

N. 8

Native and alien squirrels in Basilicata: new insights into the distribution of Sciurus meridionalis and the invasive *Callosciurus finlaysonii*

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Basilicata hosts both the endemic Calabrian black squirrel (*Sciurus meridionalis*) and the invasive alien Finlayson's squirrel (*Callosciurus finlaysonii*). In recent years, both species expanded distributional ranges rapidly, leading to the emergence of new areas of contact and overlap. This study aims to update current knowledge on the regional distribution of both species, with particular emphasis on their expansion dynamics and potential zones of interaction.
Data were primarily collected through direct observations conducted by the authors during targeted surveys aimed at detecting sciurid species. These data were supplemented with records obtained through camera trapping and opportunistic observations collected during other field activities. The habitats surveyed included mesophilous and mesothermophilous oak forests, oro-Mediterranean pine forests, and other montane and sub-montane conifer stands, all of which are considered suitable habitats for both species. Study sites were selected opportunistically across different areas of the region to verify previous records and identify newly colonized areas. Linear transects were walked to detect signs of presence, including feeding remains, direct observations, vocalizations, nests, and carcasses. Camera traps were deployed near food baits to increase detection probability. Additional records were provided by qualified observers (environmental guides and naturalists) and were included only when supported by photographic evidence and subsequently validated. Finally, data from captures carried out within the *C. finlaysonii* Control Plan implemented by the Basilicata Region were also incorporated into the analyses.
For S. meridionalis, the collected data confirm the distributional patterns reported in previous studies, documenting a continued expansion of the species' range. This expansion is particularly pronounced towards the north and north-east, with the progressive colonization of large areas of the Appennino Lucano National Park. At the same time, eastward colonization is ongoing within the Gallipoli Cognato Regional Park, while westwards towards the Campania region is evident, as shown by an increasing number of records along the Basilicata–Campania border. In contrast, the expansion of the alien *C. finlaysonii* is proceeding primarily from the Tyrrhenian coast towards inland areas, with a west–east advance in the direction of the Appennino Lucano and Pollino National Parks. Concurrently, a further range extension has been observed along the southern Tyrrhenian coast, with the species now established beyond regional boundaries in Calabria, reaching San Nicola Arcella and Aieta, at the margins of the Pollino National Park. To the north, *C. finlaysonii* has expanded into the Campania region, with records extending as far as Palinuro and the Cilento National Park.

This study provides new insight into the regional distribution of the two species. In particular, the rapid expansion of *S. meridionalis* and *C. finlaysonii* has led to the development of an extensive contact zone in the montane area between Lauria and Lagonegro, involving portions of the Pollino and Appennino Lucano National Parks. Within this area, three sites of spatial overlap were documented. The observed distribution patterns suggest that the presence of *C. finlaysonii* may constrain the westward expansion of *S. meridionalis*. The latter appears to be less successful in colonizing habitats already occupied by the alien species, a pattern consistent with potential interspecific competition or competitive exclusion. Nevertheless, further data are required to clarify the mechanisms underlying this interaction.

N. 9

The fruit-eating wolf: diet of a pack wolves at an urban rendezvous site

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Nowadays, due to its increase both in number and distribution, and thanks to its incredible plasticity (both in terms of spatial and feeding ecology), the wolf became more and more exposed to urban contests. Being an apex predator, understanding how wolf responded to urban environment and how it adapted to new scenarios, should became the focus of recent research. In this investigation we aim to study and describe the feeding habits of a pack of wolf which used, for several years, as a *rendezvous site*, an area immediately outside of a human settlement. We evaluated wolf diet by means of scats analysis, using the method of average percentage volume (AV%). In order to avoid and limit disturbance, scats were collected once the rendezvous sites were abandoned by wolves. Collection was performed in three different years (2018, 2024 and 2025). After collection, scats were washed in a sieve of 0.5 mm and the macroscopic prey remains (e.g., hairs and bones), fruit and grasses found in every scat were dried at 68 °C for 24 h. Prey remains were identified by comparison with a reference collection of mammal hairs, bones and teeth. When possible, we made an identification of the prey species age or weight class (only for the ungulates), identification which was based on the macroscopic characteristics of hairs and bones.
We collected and analysed a total of 236 scats. According to the results of scats analysis, we identified 3 main food items describing, together, more than 80% of the total diet each year: vegetables, coypu and wild boar. Considering the 3 years together the mail used item was vegetable with AV% equal to 36.9%, then wild boar with 26% and coypu with 23.1%. While, when observing the diet year by year, we found coypu being the most used prey item representing 48.6% of the total diet in 2018, vegetables being the main item in 2024 representing the 51% of the total diet, while in 2025 was the wild boar the most used category (31.1%).
Once again, this investigation confirms the tendency of wolf of being very plastic and adaptable species in facing new conditions. According to our results, we could observe how wolf was able both to exploit a typical urban prey as coypu, which represent quite new food item, and to highly rely on fruits, very abundant item in human dominated environment. To now, very few study were conducted on feeding habit in human dominated environment, thus this one represents one of the first and then, an important contribution in wolf behaviour understanding.

N. 10

Where bats dare: summer acoustic monitoring at two Alpine sites above 3,000 m a.s.l.

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Bats are known to be present in the Alps at elevations exceeding 3,000 metres. However, monitoring bat presence and activity at these elevations is challenging due to harsh climatic conditions. The use of passive bat detectors has facilitated surveys in these extreme elevations, but the models typically required for long-term deployments at these elevations are often expensive or depend on additional equipment such as solar panels, protective housings, and external batteries, which complicates installation and maintenance. For these reasons, few studies have investigated bat activity at high elevations in the Alps. The aims of this study were twofold, (I) to monitor bat activity at an Alpine pass at above 3,000 m during the warm season, and (II) to evaluate the feasibility of using bat detectors without additional auxiliary equipment at high elevations.
Two sites located above 3,000 m a.s.l. were selected within the Gran Paradiso National Park, Italy. One site was situated at an Alpine pass (Col Leynir, 3,100 m) that could potentially be used by bats for short-range movements between valleys or for long-range migrations. The second site was located at 3,433 m below the peak of Taou Blanc, at a distance of 783 m from the first site. At each site, a Wildlife Acoustic Song Meter Mini Bat detector was mounted on a pole approximately 1 m high, coupled with a temperature logger. Bat detectors operate continuously from 16 July to 17 September 2025, powered by alkaline batteries, with maintenance visits approximately every 20 days. All recorded bat acoustic sequences were manually identified and counted using BatExplorer and Kaleidoscope Lite software. The data were analysed using R.
A total of 126 recording nights (63 per sites) were acquired, resulting in 430 bat sequences, 410 recorded at 3,100 m and 20 at 3,433 m. The maximum number of species recorded in a single night at the 3,100 m site was 7, on 11 August, when the mean night temperature was 8.1°C, corresponding to the warmest period of the sampling season. However, the highest level of bat activity occurred on 7 September, at the same site, with 42 sequences of 5 species and a mean night temperature of 5°C. At the 3,433 m site, the maximum number of species recorded in a single night was two, *Nyctalus leisleri* and *Tadarida teniotis* on 7 September; these were the only species recorded at this site. In addition, acoustic sequences attributed to the *Nyctalus/Vespertilio* group were also recorded on 12 September at 3,100, at a minimum temperature of -2.7°C. Feeding activity of *Hypsugo savii* and *Eptesicus/Nyctalus/Vespertilio* were detected at 3,100 m, while social calls of *Pipistrellus pipistrellus* and *Nyctalus/Vespertilio* were also recorded at this elevation. Social calls of T. teniotis were additionally detected at 3,433 m. The most abundant group found at the Alpine pass was *Nyctalus/Vespertilio* with 141 sequences recorded, followed by H. savii (95 sequences) and N. leisleri (56 sequences). The other species and groups recorded at this site were, in decreasing order of abundance, *P. pipistrellus*, *T. teniotis*, *Eptesicus/Nyctalus/Vespertilio*, *Plecotus* spp., *Pipistrellus kuhlii/P. nathusii*, *Myotis* spp., *Nyctalus noctula*.
This study demonstrates the feasibility of investigating bat activity at elevation above 3,000 m a.s.l. over extended summer periods using ultrasonic bat detectors powered solely by alkaline batteries. Without the use of additional equipment but with periodic maintenance visits,

approximately every 20 days, detectors remained operational for more than two months. This approach enabled the recording of bat activity at 3,433 m, representing the second-highest monitored site in the Alps, and allowed continuous monitoring throughout most of the warmest period of the year. Although species richness peaked during the warmest night, bat activity reached its maximum in early September, likely reflecting migratory movements. These findings encourage further investigation of bat presence at high elevations using commercially available and easy-to-use devices, with the dual objective of monitoring long-term changes in species presence and richness in the context of climate change, and improving the understanding and monitoring of bat migration across the Alps.

N. 11

Bat activity and community composition at Alpine lakes

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Bats are a globally distributed order of mammals characterized by high ecological diversity. In Europe, bats are exclusively insectivores and their distribution is closely linked to favourable environmental conditions, including moderate temperatures, suitable weather for flight and the availability of flying insects. Lakes, ponds and other water bodies are frequently used by many bat species because they provide important resources for drinking and foraging due to the presence of insects associated with aquatic habitats. In mountain environments, harsher climatic conditions and pronounced seasonality can constrain bat activity, making the availability of suitable foraging habitats particularly important. In this context, alpine lakes may represent valuable resources for bat species inhabiting high-elevation areas. This study aims to investigate differences in bat activity and community structure at high-elevation alpine lakes. During 2024 and 2025, ten natural alpine lakes located between 2,090 and 2,805 m a.s.l. were monitored in the Gran Paradiso National Park, Italy. Each lake was paired with a control site at comparable elevation and under similar environmental conditions, located at least 500 m from the shoreline of the target lake and from any other lakes. Sampling was conducted monthly from July to September, with bat detectors deployed for three consecutive nights at each lake and control site. All acoustic recordings were manually identified using Kaleidoscope Lite and BatExplorer. For each site, bat activity was expressed as the proportion of total bat passes per taxon. Differences in bat activity between lake and control for each taxon were tested using paired-samples Wilcoxon tests, while differences in community composition were evaluated using the Permutational Multivariate Analysis of Variance (PERMANOVA). Statistical analyses were performed using RStudio.
In both sampling years, overall bat activity was significantly higher at lake sites than at control sites, with a peak in August. At lakes, the most abundant taxa in descending order were *Myotis* spp. (66.37%), followed by *Pipistrellus pipistrellus* (24.20%) and *Hypsugo savii* (4.01%). In contrast, activity at control sites was dominated by *P. pipistrellus* (61.95%), with lower contributions from *Myotis* spp. (16.63%) and *H. savii* (11.26%). In addition, the genus *Plecotus* and *Nyctalus leisleri* were detected at all monitoring sites except for two located at 2,773 and 2,827 m, although both taxa exhibited low activity levels. *Eptesicus nilssonii* was recorded at 8 of the 20 sites, accounting for 1.62% of the total activity at lakes and 2.29% at control sites, with no significant differences. Bat activity differed significantly between lakes and control sites only for the genus *Myotis*. Finally, PERMANOVA showed a significant effect of site type, indicating structural differences in bat communities between lakes and control sites.
Overall, alpine lakes supported significantly higher bat activity than control sites, confirming their role as functionally important habitats in mountain environments. The activity peak observed in August suggests that lake use is linked to seasonal windows during which thermal conditions and flying insect availability become more favorable, even at high elevations. The dominance of the genus *Myotis* at lake sites indicates a strong association with these habitats, likely related to the ability of some species to forage close to the water surface, such as *Myotis*

daubentonii. The high activity of *P. pipistrellus* and *H. savi*i, both generalist and widespread species capable of occupying a wide range of habitats and elevations, is therefore not surprising. In contrast, records of the genus *Plecotus*, likely attributable to *P. macrobullaris*, reflect the adaptation of this species to high-elevation open environments. The detection of *E. nilssonii* at the monitoring sites, although generally rare in the Western Alps, may suggest the presence of a roosting site in the study area. Finally, the low activity but broad spatial occurrences of *Nyctalus leisleri* is consistent with its high mobility and use of the area primarily as a transit zone. In conclusion, the higher bat activity and the observed difference in community composition supports the hypothesis that alpine lakes play a key role in supporting bat populations in mountain environments.

N. 12

Wild boar rooting: influence of environmental variables and effects on wood mouse abundance in a Mediterranean oak forest

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Wild boar *Sus scrofa* has been claimed to directly or indirectly impact a wide array of taxa, habitats and ecological processes through its rooting behavior. Although foraging is the main factor determining the occurrence of rooting, this activity can be also influenced by several environmental variables, such as characteristics of soil layer, habitat type and vegetation composition and structure. Among habitat types, forests are known to be characterized by high population densities of wild boar and intense rooting activity. European forests are amongst the most intensively managed forests in the world, affecting forest compositional and structural features that can potentially influence rooting activity. As part of the biotic community in forest ecosystems, ground-dwelling rodents are known to potentially suffer from this wild boar foraging activity, due to food competition and direct disturbance.
This study assessed whether acorn availability, vegetation composition and structural components of forest habitats (at ground, shrub, and tree levels) influence rooting activity, and whether the latter affects the abundance of *Apodemus* species. The research was carried out in a Mediterranean deciduous oak forest of central Italy across 12 forest sites coppiced in different years and thus belonging to a gradient of regeneration stages. We quantified rooting activity for five years and related it to the composition and structural components of forest sites, *Apodemus* spp abundances and acorn production by generalized linear mixed models.
Our results indicate that environmental variables and acorn production did not directly affect rooting extent and suggest that other local factors might have influenced the rooting pattern we recorded. Rodent abundance was not significantly affected by rooting activity, possibly due to a negligible direct disturbance and/or a low degree of food competition with wild boar.
Our study contributes to understanding factors driving this foraging behavior, which has relevant ecological and socio-economic implications.

N. 13

Which future for the hazel dormouse in the Mediterranean? Suitability changes under extreme climatic events across Biomes of Italy

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Extreme climatic events (ECEs) are increasing in frequency and intensity, yet their biodiversity impacts remain poorly understood because most studies rely on long-term climate means that fail to capture short, physiologically stressful episodes. Italy and the hazel dormouse (*Muscardinus avellanarius*) provide an ideal model system to address this gap. Italy spans steep latitudinal and elevational gradients, strong regional climatic contrasts, and three major biomes likely to experience distinct ECE regimes, enabling tests of context-dependent responses. The hazel dormouse is an arboreal, nocturnal forest specialist with limited dispersal and tight climatic constraints, so repeated ECEs may compress foraging windows and disrupt energy balance; while elevational variation in energy-saving strategies (hibernation at higher elevations, more frequent torpor at lower elevations) may further modulate sensitivity to ECEs.
We assessed how ECE-based climatic suitability may be reshuffled across Temperate Broadleaf & Mixed Forests (TBMF), Temperate Conifer Forests (TCF), and Mediterranean Forests, Woodlands & Scrub (MFW). We quantified ECEs using four five-day spell indices (cold, warm, dry, wet) derived per grid cell from daily EURO-CORDEX temperature and precipitation simulations using the *climdex-kit* Python package, and summarised them for a present baseline (1971–2000) and mid-century (2041–2071) at ~11 km resolution under two contrasting scenarios, one of mitigation and one of high-emission development. We compiled Global Biodiversity Information Facility (GBIF) occurrences, thinned them to the ECE data resolution, and accounted for sampling bias by sampling pseudo-absence preferentially in the most surveyed areas. We then fitted ensemble species distribution models (SDMs) in biomod2 with five algorithms, projected continuous suitability for present and future conditions, produced binary maps using the sensitivity–specificity maximising threshold, and evaluated performance with repeated 70:30 cross-validation with a discrimination metric quantifying separation of presences from pseudo-absences.
Dry spells emerged as the primary driver of suitability, while cold and wet spells contributed secondarily and warm spells had a comparatively minor influence. Climate suitability changes were spatially structured and highly heterogeneous, forming mosaics of gains and losses within biomes. The MFW biome showed net suitability gains but high variability under both scenarios, with stronger suitability losses under high emissions. TBMF represented a particular case, displaying consistent net suitability gains under both scenarios, with most of the biome maintaining positive suitability changes. TCF was the most impacted biome, particularly under high-emissions, where the mean suitability change appeared near-neutral because gains and

losses offset each other, but transitions skewed toward losses and strong internal reshuffling. Global climate mitigation is the only way to limit ECE intensification, but habitat management remains crucial at local scale. Expanding forest cover and prioritising targeted reforestation, especially where woodland connectivity is disrupted, can buffer ECE impacts and strengthen ecosystem resistance; for the hazel dormouse, continuous forest cover provides the functional connectivity needed for dispersal and range shifts toward climatic refugia. Efforts should be concentrated in TCF, where losses and fragmentation risk are greatest. A key next step is to integrate land-use with climate projections to assess persistence across Italy, because species suitability will ultimately depend on forest availability and quality. We acknowledge support from LIFE21-CCA-IT-LIFE BEEadapt/101074591.

N. 14

Temporal interactions between wolves (*Canis lupus*) and wild ungulates in the Verbano-Cusio-Ossola Province, Western Italian Alps

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Wolves (*Canis lupus*) are generally considered generalist and opportunistic predators, which typically select the most vulnerable and abundant prey species living in their territories. We investigated temporal interactions between wolves (*Canis lupus*) and wild ungulates to evaluate the relationship between predator and potential prey activity patterns. The research was carried out in the Verbano- Cusio-Ossola Province (VCO) in the Western Italian Alps, characterised by a rich wild ungulate community consisting of four stable species: wild boar (*Sus scrofa*), red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*) and chamois (*Rupicapra rupicapra*). From April 2025 to December 2025, we recorded the occurrence of the target species using camera-trapping. To increase detection probability, camera traps were spaced strategically based on previous knowledge of wolf and ungulate presence in the study area. We considered two distinct ecologically based seasons: spring-summer (from 1 April to 30 August) and autumn-winter (from 1 September to 31 December). We studied the activity patterns of wolves and wild ungulates to estimate the probability of co-occurrence within a given time period. All analyses were conducted on circular data, assuming temporal independence among detection events. Species activity patterns were estimated using a kernel density estimator to model the probability density function of detection times. Temporal overlap between wolves and each wild ungulate species was quantified using the coefficient of overlap (Δ). Confidence intervals for overlap estimates were obtained via non-parametric bootstrap resampling (1,000 iterations). Overlap values were further categorised as *low*, *moderate*, or *high* based on the 50th and 75th percentiles of all pairwise comparisons, to facilitate interpretation of relative activity synchrony. Over more than 1,000 camera trap days, we recorded 586 detection events for the target species (wolf: n = 126; wild boar: n = 64; red deer: n = 226; roe deer: n = 120; chamois: n = 50). Wolves exhibited predominantly crepuscular and nocturnal activity patterns in both seasons, with peak activity between midnight and dawn. Among wild ungulates, red deer and roe deer were predominantly crepuscular but both showed day- and night-time activity too; wild boar were primarily nocturnal, and chamois showed pronounced daytime activity. Temporal overlap with wolves varied among species and seasons: during spring-summer, high overlap was observed with red deer (Δ; 95% CI = 0.83; 0.70 - 0.88), moderate overlap with wild boar (0.79; 0.61 - 0.86), and low overlap with roe deer and chamois (0.67; 0.54 - 0.76 and 0.40; 0.26 - 0.51, respectively). In autumn-winter, overlap patterns remained broadly similar, although the overlap with the wild boar was high (0.84; 0.59 - 0.87) while the overlap with the red deer was moderate (0.82; 0.66 - 0.89); overlap with roe deer and chamois remained low. Although our results are partial, as the study is ongoing, they highlight interesting local interactions with seasonal adjustments along the temporal axis that likely contribute to shaping predator-prey dynamics. Future steps of this research will include evaluating the importance of each wild ungulate species in the wolf diet through diet analyses, to better understand the functional relevance of temporal overlap in predator-prey interactions.

N. 15

Patterns of wolf depredation on livestock in a cattle predation hotspot area of the eastern Italian Alps

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In the Lessinia area, a plateau region located between the Autonomous Province of Trento and the Veneto Region (eastern Italian Alps), the first wolf pack of the Eastern Alps established between 2012 and 2013. Since wolf return, conflicts with the livestock sector have increased, and the area has become a hotspot of wolf depredation at the provincial scale. Lessinia represents a particularly relevant management case, as dairy cattle constitute the livestock category most frequently affected by wolf predation, an uncommon pattern both at the local and the international scale. Much of the area lies within the Lessinia Regional Natural Park, making it a particularly interesting case of human-wildlife conflict and coexistence within a protected area. We provided a comprehensive overview of wolf depredation on livestock in Lessinia over the period 2012–2024, with the aim of identifying recurring characteristics and spatio-temporal patterns of attacks, with a specific focus on cattle. We analysed spatial distribution and potential aggregation of depredation events, and explored correlations of attack numbers with factors such as landscape features (e.g., distance to pasture huts/malghe and forest edges) and wolf abundance. Analyses were conducted at two spatial scales: a broader study area was defined to provide a general overview of all cases recorded, and a more restricted area corresponding to high-elevation pastures was identified to analyse depredation cases on cattle.
Within the broader study area, 711 depredation events involving 952 animals were recorded. Cattle accounted for 91.7% of cases, while sheep and goats represented 5.6%. The highest numbers of cattle depredation events were recorded in 2017 and 2022, with attacks mainly occurring in late summer. In the high-pasture area, 499 depredation events involving 574 cattle were documented. Friesian cattle were the most frequently affected breed, followed by crossbred cattle, Charolais and Limousin. Predation predominantly involved subadult cattle, with a mean age of 14 months. Individuals younger than 20 months accounted for the majority of cases (81.2%), whereas adult cattle were rarely affected. On average, 1.2 animals were involved per depredation event. Most attacks occurred at night, followed by early morning hours. Electrified prevention fences were documented at a single pasture. Depredation events were unevenly distributed across the landscape: thirteen pastures (*malghe*) suffered ten or more depredation events, and together accounted for approximately half of all cattle predation events recorded during the study period in the whole area. Several spatial clusters of depredations were identified, which increased in number over time. Depredation frequency was positively correlated with annual wolf abundance and pup numbers, increased near pasture huts/*malghe*, and decreased near forest edges.
Overall, the study documents a context in which subadult cattle represent the primary domestic prey of wolves, highlighting the species' high ecological plasticity in response to prey availability. These findings underscore the need for locally adapted prevention strategies to reduce wolf–livestock conflict and support coexistence in this alpine landscape.

N. 16

The citizen science project “Studiamo insieme lo stambecco”

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„Studiamo insieme lo Stambecco“ is a multi-year citizen science project that aims to monitor the colony of Alpine ibex (*Capra ibex*) in the Dolomite groups of Antelao, Marmarole, and Sorapis (Cadore, Belluno), delimited to the north by the Ansiei stream, to the southeast by the Piave river, and to the southwest by the Boite stream. The project was born from an idea of the Veneto Friulano and Giuliano Scientific Committee of the Italian Alpine Club (CAI) with the scientific supervision of the Giancarlo Ligabue Natural History Museum of Venice and is sponsored by the Province of Belluno. The operational center is the Pietro Galassi refuge (CAI-CNR climate and environment sentinel refuge), managed by the Mestre section of the CAI. The current colony derives from a reintroduction in the eastern Italian Alps, which began in 1965 with eight individuals released on the slopes of Croda Marcora (Sorapis), coming from the Pontresina Reserve (Switzerland); a reinforcement was carried out in 1975 with four more specimens. From this small number, a population developed that is now well-rooted in the territory, despite some difficulties due mainly to high inbreeding and health problems (sarcoptic mange). In 2025, ten more specimens were released (5 males and 5 females), coming from the nearby Marmolada colony. The objective of the CAI project is to collect data on composition, land use, health status, and distribution of the colony. A specific brochure was distributed to refuge users with information on the history of the colony, on the discrimination of age and sex of the ibex, as well as a species detection form. Mountain frequenters are invited to take note of a few simple data points regarding the sighting of herds or single specimens in the study area. Anyone who spots one or more ibex is invited to send their observations, and possibly a photo, to info@progettostambecco.it or through the web page www.progettostambecco.it. The requested information includes date and time of the observation, description/GPS coordinates of the location, altitude and slope exposure, and number of animals sighted (distinguishing them, if possible, by sex and age). To the data collected opportunistically by hikers are added the results of systematic monitoring and censuses that some CAI members, duly trained and coordinated, carry out alongside the provincial police of Belluno. The data collected and archived at the end of 2025 are over 220 and already allow for sufficient information to investigate the objectives listed above. From all the data collected in the 2025 monitoring, 212 individuals are conservatively estimated, distributed as follows: 24 kids, 25 one-year-old juveniles, 70 males (+4 still alive after the 2025 releases), 70 females (+5 still alive after the 2025 releases), 14 indeterminate. The colony apparently enjoys a fair state of health, despite the presence of the now endemic sarcoptic mange (one adult male visibly affected by mange in the autumn of 2024 and one young male died of mange in August 2025). The colony occupies, albeit with substantial differences, the entire investigated territory. The preferred habitat is characterized by very steep or almost vertical rocky slopes with discontinuous pastures where sparse vegetation grows, and scree slopes with pioneer glareicolous vegetation. The preferred slopes are the sunny ones facing south which are never abandoned during the entire course of the year, with a clear prevalence for SE (31%), S (20%), SW (18%). The northern exposure N (11%), NE (6%), NW (5%), is frequented almost exclusively in the summer months. Less used are the E (5%) and W (4%) quadrants. In 2026, at the established end of the project (2021-2026), the results of the research will be presented, along with a documentary that will tell the story of the ibex and the mountains that host it, alternating ecological and biological information of the species with interviews with experts and protagonists of the study.

N. 17

Characterization of wolf resting sites in a Mediterranean coastal area

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Rest is a fundamental component of the activity rhythms of wild species, including large carnivores. In wolves (*Canis lupus*), rest is essential for proper nervous system functioning and for maintaining individual physiological and behavioral performance.
However, resting periods also represent phases of increased risk, as individuals are more vulnerable to disturbance and to attacks by other wild species. Consequently, the selection of a resting site that is both secure and difficult to detect is critical.
Wolves spend up to 50% of their time resting, indicating that resting site selection constitutes a particularly important aspect of their ecology. We investigated wolf resting site selection in a Mediterranean coastal area characterized by high levels of human disturbance. Four individuals equipped with GPS radio collars were monitored to identify resting locations. A resting site was defined as a location where successive wolf GPS fixes overlapped for more than four consecutive hours.
Between May 2023 and September 2024, we identified 220 resting sites using cluster analysis of GPS fixes. All identified resting sites were visited in the field, where we recorded environmental variables including visibility, distance to the nearest artificial barrier, and dominant plant species. These variables were compared with those measured at 404 randomly generated points. Resting site characteristics were analyzed in comparison with random points using a generalized linear mixed model (GLMM) with a binomial error distribution and logit link function, implemented in the lme4 package in R version 3.6.2. The response variable was binary (1 = resting site; 0 = random point).
Differences in plant species associated with resting site selection were assessed using analysis of variance (ANOVA). Generalized linear models (GLMs) were used to assess the probability of wolf resting site occurrence in relation to visibility (parameter estimate = −0.008, SE = 0.004), distance to the nearest fenced area (parameter estimate = 0.007, SE = 0.002), and distance to the nearest settlement (parameter estimate = 0.0005, SE = 0.00009). Resting sites were located in areas with a mean visibility of 100.7 m. Mean distances of resting sites were 246.7 m from roads, 137.6 m from buildings, and 76.0 m from fences.
Vegetation analysis indicated that *Erica scoparia* was the predominant plant species at resting sites (ANOVA: $F = 69.858$, $p < 0.001$). Wolves selected resting sites at greater distances from buildings and roads. The study area is characterized by a dense network of forest and paved roads that are intensively used during daylight hours. Our results confirm that wolves tend to avoid areas with high levels of human disturbance, particularly during resting periods. Resting site selection was also strongly influenced by vegetation structure. Wolves preferentially selected habitats with dense vegetation cover, which provides effective concealment from human detection. Pine forests are widespread within the study area and are characterized by an understory dominated by Mediterranean scrub species. Among these, common heath (*Erica scoparia*) was most frequently selected, forming extensive, dense shrub cover associated with markedly reduced visibility.
Our results contribute to improving knowledge of wolf resting site characteristics in Mediterranean environments and provide information that may support forest management planning by promoting the conservation of areas most suitable for resting site establishment by this species.

N. 18

Demographic data on the European snow vole in the Gran Sasso and Monti della Laga National Park

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The European snow vole (*Chionomys nivalis*) is a South European–Turanian species predominantly lives in rocky mountain habitats. The species is poorly known and characterized by a fragmented range. In Italy, its distribution includes the Alps and some areas of the central-northern Apennines, where reference information is still based on sporadic records. Knowledge on the ecology and distribution of the European snow vole remains limited, a critical gap given the potential sensitivity of this mountain species to climate and environmental changes.
In 2025, a long-term monitoring study on the European snow voles was initiated in the Gran Sasso and Monti della Laga National Park to collect data on the species' ecology and biology. The project mainly focuses on investigating individual and population parameters, to identify the main factors influencing European snow vole populations in central Italy. Demographic data were collected at the Campo Imperatore area using a capture–mark–recapture protocol. Two trapping grids were settled, each consisting of approximately 50 traps. Two sampling sessions were carried out during the year, at the beginning of July and at the end of August. Traps were checked twice daily over five consecutive days in each grid and session.
Overall, we captured and individually marked 67 individuals in the study area. Preliminary results from the first year of sampling, derived from spatially explicit capture–recapture analyses, yielded a density estimate of approximately 11 individuals per hectare. During the August session, around 50% of previously marked individuals were recaptured. The age structure of the population showed a clear prevalence of adults (87%) over juveniles (13%). Females were more frequently captured than males, and a high proportion of adults were in reproductive condition in both sessions, although a decrease was observed over the summer (76% in July and 43% in August). In 2026, a third sampling grid will be established and three capture sessions per year will be carried out to improve the robustness of individual and population parameter estimates.
Overall, this project will provide valuable information at both local and broader scales, improving knowledge on the ecology of the European snow vole and enabling evaluation of its potential role as a sentinel species for monitoring changes in alpine and Apennine ecosystems.

N. 19

Updates on the distribution and population structure of Eurasian beavers (*Castor fiber*) in Umbria

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The Eurasian beaver (*Castor fiber* Linnaeus, 1758) has seen a recent population expansion across Europe reappearing in several regions thanks to natural expansions, conservation programs, and "beaver-bombing", unauthorized releases that were observed in several European countries throughout the last decades. Umbria and Tuscany are two regions of Central Italy that were, most likely, affected by a beaver-bombing event that is estimated to have occurred between 2018 and 2021. Initial records of presence of beavers in streams from Central Italy were scattered, raising questions about the actual distribution of the species and on the consistency of the population, especially considering the strong ecological impact that an established beaver population can have on the riparian ecosystem. Several research efforts across the years have highlighted the genetic profile of this new population, shedding light on their behavior and the impact of beaver activity in relation to other animal communities. Updated information on beavers' spatial distribution and population status are essential to steer conservation and management efforts in order to reduce the impact of the increasing beaver population on human activities. The aim of this contribution is to provide an updated overview of the current distribution and genetic structure of the Eurasian beaver population in Umbria. Data were collected between 2021 and 2026 through a combination of field surveys and camera trapping. Surveys were carried out along the main course of the Tiber River and its tributaries starting from the North-Western sectors collecting evidences of indirect presence signs, such as gnawed and felled trees or feces by walking in the water or along the river banks. Opportunistic records of dead individuals were also documented. Camera traps were deployed on sites of both confirmed and suspected bever activity to validate indirect observations and confirm active presence. Beaver DNA was extracted from fecal, tissue and bone samples and a fragment of the control region was amplified and sequenced to identify the mitochondrial haplotypes. The results highlight an expansion and consolidation of the Eurasian beaver population in Umbria. After the first nuclei detected along the north-western part of Tiber River, new records progressively filled previously isolated stretches of the river system. To date, two new isolated presence sites were detected. New evidence includes the discovery of a nearly completed beaver skeleton, unearthed on March 2023 from a riverbank and genetically attributed to the subspecies *Castor fiber galliae* (Saint-Hilaire,1803). Camera trapping successfully confirmed active beaver presence at several locations, and the necroscopic inspection of a road killed female showed the presence of placental scars in the uterus, a sign of multiple embryonic implantation. Our findings indicate that the Eurasian beaver is no longer sporadically occurring in the region but has established a reproducing and expanding population along the Tiber River and its tributaries. The observed increase in signs of presence suggest ongoing dispersal and habitat suitability across the regional river network. Even though the population has likely been originated from illegal releases, the species now appears to be naturally expanding its range, raising important management and conservation challenges, especially regarding potential conflicts with human activities across the riparian ecosystem. Continuous monitoring is therefore essential in order to identify population trends, ecological impacts and connectivity with other population. These results could provide a baseline for future management strategies, contributing to the broader understanding of the species recolonization dynamics in peninsular Italy.

N. 20

A systematic review of the role of community science in European wildlife governance

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Community science (CS, previously often referred to as citizen science) has become a vital tool in wildlife monitoring, contributing to a more comprehensive understanding of changes in species distributions and population trends. Consequently, the role of CS in informing wildlife management decisions has been increasingly discussed, with growing support for the adoption of CS. However, the extent to which evidence from CS-based wildlife monitoring projects translates into concrete governance outcomes remains largely unclear.
To address this knowledge gap, in the context of the TransWILD Biodiversa+ project, we conducted a systematic literature review following PRISMA guidelines. In total, we recorded 1588 articles and screened their abstracts using three exclusion criteria: i) absence of a wildlife or biodiversity focus; ii) absence of citizen or stakeholder involvement in wildlife monitoring; iii) lack of a clear link to governance. A full-text analysis was performed on 449 articles, after which we excluded studies that: did not focus on CS initiatives in Europe or had no clear implications for wildlife management and policy.
Ultimately, this filtering resulted in 66 relevant articles. Mammals were the most represented taxonomic group (n=41), followed by birds (n=23), invertebrates (n=10), reptiles (n=9), fish (n=8), and amphibians (n=7). Participant involvement included multiple activities: species presence recording; sample collection; hunting bag recording; interviews; questionnaires; workshops; and focus groups. We identified five main categories of author-reported recommendations: 1) policy and law (n=39); 2) human-wildlife conflict mitigation measures (n=24); 3) protected area establishment and conservation measures (n=21); 4) education and behavioural change (n=17); 5) wildlife monitoring (n=17). The 'policy and law' recommendation category encompassed management strategies and plans, conservation policy, creation of laws and protocols, and hunting season modifications. In contrast, only a few articles (n=7) reported that CS initiatives had concrete management implications, such as changes to hunting practices, mitigation of vehicle collision, or invasive species management.
Our analysis echoes ongoing debates on the role of CS as a policy-relevant tool, with many studies framing CS outputs as having implications for policy and law. However, our findings indicate that CS is commonly perceived as contributing to wildlife governance across multiple scales and dimensions, from informing the establishment of protected areas, to supporting local behavioural changes in favour of wildlife. While the direct impact of CS on formal wildlife policy remains poorly documented, we suggest that the potential implications of CS are likely to go far beyond the realm of policy and legislation. Further research should therefore focus on systematically analysing and unpacking CS project reports, official policy documents, and grey literature to better assess how, and to what extent, CS is shaping wildlife management and policy outcomes.

N. 21

The effects of climate change on the Alpine ibex (*Capra ibex*): thee colony in the Orobie Alps

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The current distribution of the Alpine ibex (*Capra ibex* Linnaeus, 1758) in the Alps is the result of reintroduction programmes carried out during the last century. In the Orobie Alps, the „Progetto Stambecco Lombardia“, initiated in 1984, led to the establishment of two colonies (eastern and western colony). In 2024, forty years after the first reintroductions and sixteen years after the last census, a new assessment was conducted to evaluate the conservation status of these populations in the context of increasing vulnerability of the species to climate change.
The census was conducted using the block-count technique to estimate population size and structure (sex and age classes). For a subpopulation of the eastern colony, managed by the AFV Valbelviso– Barbellino, monitoring data collected yearly since 2008 were analysed to investigate population dynamics and juvenile survival. Exploratory analyses and generalized linear models were used to evaluate relationships with climatic variables and vegetation productivity, including the Normalized Difference Vegetation Index (NDVI).
In June–July 2024, 1460 individuals were counted, including 180 juveniles, corresponding to an average annual growth rate of +2.57% since previous surveys (2004–2008). Population trends differed between colonies, with a decline in the western colony (–3.17%) and growth in the eastern colony (+4.62%). Juvenile classes declined over time, while adult classes remained stable in the western colony and increased in the eastern colony. In the AFV subpopulation, population growth was positively related to vegetation productivity and growing-season length, whereas juvenile survival was negatively affected by the timing of peak vegetation growth.
The 2024 census confirms the long-term success of the reintroduction programme in the Orobie Alps but indicates a general ageing of the population, likely driven by reduced juvenile survival. Differences between colonies suggest an influence of local environmental conditions. Overall, the results highlight the role of climate- and vegetation-related factors in shaping Alpine ibex population dynamics and underline the need for continued and expanded monitoring to support effective conservation strategies.

N. 22

Socio-ecological suitability of urban-dominated landscapes for the Eurasian otter (*Lutra lutra*)

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The return of carnivores to areas where they were once driven to extinction provides an opportunity to examine how they interact with various anthropogenic factors and identify which one most affects their survival and resilience. Despite urban wildlife having recently received attention by researchers, there is still limited understanding on if and how the Eurasian otter (*Lutra lutra*) could coexist with humans in urban habitats. We run a systematic survey and non-invasive genetic sampling to study the otter population established in the state-city of Berlin (Germany), one of the first urban contexts colonized by the species in Europe. A standard bridge survey method was run across the city with two temporals replicated to allow the use of occupancy models for the estimate of occurrence and detection probabilities. We identified 143 marking sites and collected 34 spraints for genetic analyses that are still ongoing. Preliminary results allowed to confirm the presence of otters in three main areas of Berlin (Pankow, Reinickendorf/Spandau and Treptow-Köpenick/Marzahn-Hellersdorf), located along the watercourse Havel, Spree, Panke, Tegeler Fließ, Wuhle, Erpe, Teltow Canal, and Löcknitz; on Müggel and Tegeler lakes, along small ditches whereas the species was not detected in the core city centre. The ongoing occupancy modelling will likely allow us to identify environmental factors affecting both the otter occurrence and its detectability along a natural-to-urban gradient.

N. 23

Assessing the viability of the Apennine brown bear population (*Ursus arctos marsicanus*): a cautious outlook

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The endemic, small, and relict Apennine brown bear population (*Ursus arctos marsicanus*) has been living in the central Italian Apennines in complete genetic isolation for approximately 1,500 years, showing high degree of phenotypic differentiation. Population estimates conducted in 2011 and 2014 indicated around 50 individuals mainly restricted in a core area of 1,500-2,500 km2, corresponding to the Abruzzo, Lazio and Molise National Park (PNALM) and surrounding areas. This population carries highly reduced genetic variability and suffers from high human-related mortality and a relatively low reproductive rate. Despite the availability of suitable habitat at the landscape scale, no significant increase in the population or expansion of its range have been observed during the past decades. Even though previous assessment of Apennine brown bears' viability estimated a negative population growth rate r = – 0.013 (SD = 0.103) and a 17% extinction risk in 100 years, those results should be considered optimistic, as mortality rates were not differentiated between yearling, sub-adult, and adult individuals. This study is a further attempt to more conservatively estimate the probability of extinction, the growth rate, and the genetic variation over time of the Apennine brown bear population accounting for differential mortality rates among age classes and the potential effect of inbreeding depression. Using Vortex, we first developed a baseline scenario to project population dynamics under current demographic and genetic conditions for the next 100 years. Secondly, we accounted for 3 levels of inbreeding depression (3.14, 6.29 and 12.3 lethal equivalents) and different contributions from recessive lethal alleles (50% and 100%). Finally, we performed a sensitivity analysis under a ±20% variation of the most critical demographic parameters.
Our baseline scenario predicted a 79% probability of extinction in 100 years, corresponding to an average annual population decline of 3.5%, and a mean time to extinction of 64 years (SD=18.5). The expected mean heterozygosity declined from 50% at the beginning of simulations to 7% (SD=0.167) in the surviving population, indicating an 86% loss of genetic diversity during a 100-year period. When projecting population dynamics under the effect of inbreeding depression, the extinction probability increased to 93–100% in 100 years. Our findings suggest that the current demographic conditions are likely to support stable population dynamics limited to the next 25 years, but a steady decline will continue for the following 75 years, bringing the population to the brink of extinction. Based on our sensitivity analysis, the proportion of reproducing females, cub mortality, and the mortality rates of adult and yearling females were the most influential parameters affecting the model outcomes. While warning that the risk of extinction of the Apennine brown bear population might be significantly higher than previously estimated, our study emphasizes the importance of field-based investigations to obtain accurate estimates of critical demographic and genetic parameters. Meanwhile, the stability of the population in the forthcoming years should not necessarily be interpreted as a conservation success. More effective management interventions, and especially a more aggressive reduction of human-related mortality, are of paramount importance to sustain and enhance in the short term the dynamics of this relict and isolated bear population.

N. 24

High-elevation rodent communities in the Maritime Alps with a focus on the snow vole *Chionomys nivalis*

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Mountain environments are characterized by steep environmental gradients over short distances, which strongly influence species distribution, abundance, and the ecological strategies adopted to cope with extreme climatic conditions. Rodent communities play a key role in alpine food webs and ecosystem processes; in particular, specialist species are among the most vulnerable due to their narrow ecological niches and limited dispersal. Rodents also contribute to vegetation renewal by acting as consumers and, above all, as secondary seed dispersers, thereby influencing the structure and dynamics of plant communities, especially in alpine environments where plant regeneration is already strongly constrained. Studying individual behavioral traits, such as exploration and activity, is therefore crucial for understanding species' ecological roles. In this study, we analyzed rodent communities along an altitudinal gradient with the objectives of characterising community structure and composition, estimating relative abundance and spatial distribution, and assessing individual behavioral traits of the snow vole.

Fieldwork was conducted from July to September 2025 in the Maritime Alps, comparing three study areas located at 1813 m a.s.l. (A), 2026 m a.s.l. (B), and 2404 m a.s.l. (C). In each area, a scree slope was selected, and 50 Sherman traps were arranged in a grid at 10 m intervals, checked twice daily at 12-hour intervals over four consecutive days (three trap nights). For each trap location, the presence or absence of surrounding vegetation and the size of three adjacent rocks were recorded. All captured individuals were identified to species and subjected to capture–mark–recapture (CMR) protocols. Snow voles (*Chionomys nivalis*) and garden dormice (*Eliomys quercinus*) were marked with PIT tags; only snow voles were also subjected to behavioural testing (the Emergency Test and the Open Field Test) once per month; all other species were marked using fur clipping.

A total of 333 captures were recorded: 280 in area A, 50 in area B, and 15 in area C. The most abundant species were the snow vole (146 captures) and the bank vole (*Myodes glareolus*, 159 captures). Other species recorded included the wood mouse (*Apodemus* sp.), the garden dormouse, the stoat (*Mustela erminea*), and a shrew (*Sorex* sp.). We identified 21 distinct snow vole individuals in area A, 6 in area B, and 6 in area C. A progressive increase in the number of captured individuals was observed over the sampling period (area A: 9 individuals in July, 14 in August, and 15 in September; area B: 3 in July, 4 in August, and 3 in September; area C: 0 in July, 2 in August, and 5 in September). Results from behavioral test are currently under analysis.

Overall, our findings confirm the influence of the altitudinal gradient on rodent community structure, with a progressive decrease in both population density and species diversity at higher elevations. The dominance of the snow vole at high elevations and the concentration of bank voles at lower sites indicate strong ecological specialization and spatial segregation driven by environmental conditions. The seasonal increase in the number of captured individuals further suggest possible temporal variation in resource availability or population dynamics along the elevational gradient.

N. 25

Living separately under the same canopy: cohousing of edible and hazel dormouse in a coppice in Central Italy

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In the "Lago di Vico" Natural Reserve (Lazio, Italy), extensive hazelnut plantations border natural woodlands. These plantations provide an abundant food resource during the summer season and may attract various wildlife species, including the edible dormouse (*Glis glis*) and the hazel dormouse (*Muscardinus avellanarius*). Consistently, many landowners report crops damage attributed to these species, and to the edible dormouse in particular, although the hazel dormouse may also feed on nuts. To prevent conflicts between human activities and wildlife in a changing environment under the pressure of heavy human presence, appropriate management and preventive measures are therefore required. The main aim of this study was to obtain the first data on the status of the target species in one of the wooded areas adjacent to the plantations within the Reserve, representing a preliminary step toward the development of any future management actions.
Data were collected using a classical study design, complemented by some innovative elements, such as considering often ignored forestry variables and taking into accounts the presence of plantations. A total of 44 nest boxes were installed along four transects (mean nest boxes distance within a transect
$\pm$ SD = 50 $\pm$ 18 m, range = 24 - 97 m; mean distance between transects $\pm$ SD = 51 $\pm$ 24 m, range = 26 – 102 m), at slightly different altitudes (between 530 meters a.s.l. and 650 meters a.s.l.) within woodlands adjacent to hazelnut plantations and at increasing distances from them. Data were collected periodically (approximately every 30 days, or every 15 days for certain months) from September 2022 until December 2023, reaching a total of 20 surveys. We considered forest structure variables related to tree structure (e.g. stem density), fruit production and distance from hazelnut groves. The influence of these variables on the two dormouse species was first analysed using GLMs and subsequently through Single-Season Single-Species Occupancy models.
The results revealed opposite responses of the two dormouse species to nest boxes distance from the hazelnut plantations: the edible dormouse was more likely to be present closer to the plantations, whereas the hazel dormouse showed a higher probability of occurrence at greater distances. Furthermore, our findings are consistent with the presence of interspecific competition between the two species, potentially related to both food sources and shelters. The edible dormouse seems to respond more strongly to specific environmental factors in line with recent studies suggesting that this species is more specialised than previously assumed. Conversely, the hazel dormouse, contrary to previous assumptions, seems to exhibit a lower degree of specialisation, as also reported by other authors. These results contribute to a better understanding of the relationship between the target species and human activities and provide useful insights for developing suitable conservation measures in a highly human-influenced environment.

N. 26

Shifting paths in a dry landscape: seasonal space-use strategies of African savanna elephants

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African savanna elephants (*Loxodonta africana*) inhabit semi-arid landscapes where spatial use is strongly constrained by seasonal resource availability and increasingly influenced by human activities. In regions characterized by limited water and forage distribution, elephants must dynamically adjust their space-use strategies in response to shifting ecological constraints and human presence, making them a compelling model for understanding mammalian behavioural and ecological responses to environmental heterogeneity and anthropogenic pressures. This study investigates how seasonal resource limitation, landscape structure, and human activity interact to shape elephant habitat use within the Klip River Valley, a semi-arid landscape in the north-western Namibia.
Elephant occurrence was assessed through an extensive camera-trap survey conducted across wet and dry seasons. Habitat use was quantified using relative abundance indices and single-season occupancy models that explicitly accounted for imperfect detection. A suite of environmental, topographic, anthropogenic and biological covariates was evaluated to explore the drivers of space use and their seasonal variability. Elephant habitat use showed marked seasonal differences, reflecting changes in resource distribution and landscape constraints and highlighting the dynamic nature of space use in arid systems. By integrating camera trapping, remote sensing, and occupancy modelling, this study provides a fine- scale, seasonally explicit assessment of elephant habitat use in a community-managed semi-arid landscape. The results contribute to understanding how large mammals adapt their distribution in response to complex ecological and anthropogenic gradients, offering insights relevant for conservation and management in changing environments.

N. 27

Morphological adaptation of *Herpailurus yagouaroundi* in antropized forest of Guatemala

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Felid phenotypic diversity is frequently shaped by habitat structure and reflected in patterns of habitat use. In the Neotropics, the jaguarundi (*Herpailurus yagouaroundi*) exhibits two main colour morphs associated with distinct ecological settings: melanistic individuals are typically observed in dense forests, while non-melanistic ones tend to occupy more open habitats. However, how this separation manifests at finer spatial scales, particularly under significant human influence, remains poorly understood.

This study examines how different jaguarundi phenotypes coexist in a modified tropical montane landscape in western Guatemala. We conducted a year-long camera-trap survey, deploying 30 cameras in a grid across 13.6 km² encompassing fragmented forests, agricultural land, and peri-urban areas. Cameras operated continuously over 24 hours, yielding nearly 4,000 trap-nights. Jaguarundi detections were recorded as part of a broader multi-species monitoring effort. These data revealed which phenotypes were present, their activity patterns, and their spatial associations with other carnivores and prey.

In total, we recorded 12 independent detections of jaguarundis at 6 camera stations. Both melanistic and non-melanistic individuals were observed, including at one location where the two morphs were recorded 17 days apart at approximately 3,000 metres above sea level. This represents the first confirmed co-occurrence of both colour morphs in Guatemala. Notably, all detections occurred during daylight hours, and jaguarundis were recorded only in areas with minimal canid activity, with no clear association with broader land cover types.

These findings suggest that in fragmented, human-modified environments, the available ecological space may be constricted, potentially blurring the habitat-based phenotypic segregation observed at larger scales. The local co-occurrence of both morphs demonstrates considerable adaptability even under human pressure. These results underscore the importance of investigating fine-scale ecological dynamics to better understand how different phenotypes persist among elusive carnivores.

N. 28

Unexpected neighbors: what DNA metabarcoding tells us about wolf diet in the Salento peninsula

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Large carnivores play a key role in maintaining ecosystem balance by regulating trophic dynamics and supporting fundamental ecological processes. The wolf (*Canis lupus*), as an apex predator and facultative scavenger, provides an ideal model to investigate how feeding ecology responds to anthropogenic pressures in human-modified landscapes.
In 2017, more than a century after the last confirmed occurrence, wolves were reported in the Salento Peninsula, in the southern part of the Puglia region; an area previously considered ecologically unsuitable for the species. The recent recolonisation of this area is of management interest due to the potential implications for local farmers, as wild prey for wolves are relatively scarce in Salento. Here, we investigate wolf diet in Salento by means of DNA metabarcoding, a ttechnique that enables the identification of prey items not only from hard (observable) remains, as traditional scat analysis methods, but also from soft and unobservable tissues, providing a more comprehensive representation of diet.
From December 2023 to January 2025, within the framework of the *Hic Sunt Lupi* project, 40 faecal samples were collected across the Salento Peninsula (≈5,500 km²). Samples were collected along paths and roads commonly used by wolves by trained operators accompanied by molecular dogs, previously trained to locate wolf scats. Samples were stored in plastic bags and frozen at –20 °C. DNA was extracted using the Quick-DNA Miniprep kit (Zymo). Prey composition of the diet was assessed using the vertebrate-specific 12S rRNA marker, amplifying the ~150 bp hypervariable V5 region with a specific primer pair. Tagged amplicons were pooled and sequenced using next-generation sequencing. Reads were processed through a customised bioinformatics pipeline using the DADA2 open-source R package.
Results indicate that the wolf diet includes both wild prey (e.g., *Suc scrofa* and *Vulpes vulpes*) and domestic species (e.g., *Capra hircus*, *Ovis aries* and *Equus asinus*). Based on scat presence/absence data, wild prey and domestic prey contribute in roughly equal proportions to overall prey occurrences. Among wild prey, wild boar is the most recurrent, while domestic occurrences are largely represented by goats (the most frequent item) and sheep.
This study highlights the need for monitoring the actual impact on livestock farming and for informing effective conflict management in this area. In particular, heavy reliance by wolves on domestic stock and other foods of anthropogenic origin as the one we reveled in Salento, offers a unique opportunity to study the effects of such a diet on the main life history traits (e.g., pack size and composition) and behaviour (territoriality, forging behaviour, circadian rhythms and relationship with humans) of wolves.

N. 29

From emergency to One Health approach in urban areas

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In 2020, wild boar control measures began in the areas surrounding Perugia and Corciano following the first reports of their presence in urban areas in 2017. The continuous increase in reports and the development of a new approach to wildlife management (One Health) now require a review of management methods and strategies from an adaptive perspective, although some regulatory and technical obstacles have been overcome over the years.
Even before the "Piano di interventi urgenti per la gestione, il controllo e l'eradicazione della Peste Suina Africana nei suini d'allevamento e nella specie cinghiale in Umbria" (PRIU, July 2022) and the "Piano di controllo nazionale per la fauna selvatica" (July 2023), thanks to the "Protocollo di intervento in ambito urbano" approved by the Prefecture (April 2021) and the establishment of a special Management District (D14, October 2021), it has been possible to carry out culling operations in an area of approximately 15,000 ha, characterized by a high concentration of inhabitants.
In six years (2020-2025), a total of over 600 wild boars were culled, at least 80% of which were divided equally between hunting and trapping. The effectiveness of the various techniques has been strongly influenced over the years by the collaboration with the operators employed (volunteer hunters). Annually, the use of various types of cages (including Pig Brig since May 2024) has always allowed the highest number of removals to be achieved through trapping, except in 2023.
As it becomes increasingly challenging and important to remove urban wild boar populations, greater issues of availability and acceptance are emerging among the collaborators and citizens involved. Collaboration with motivated operators is subject to the dynamics of the relationship between wild boar hunters within the "Ambito Territoriale di Caccia Perugia 1" (ATC 1 PG) and has varied over the years depending on the people involved.
The community is strongly divided between those who perceive wild boars as a significant risk to public safety and those who have even freed them from their cages on several occasions before the intervention of officials or feed them near their homes.The authorities most involved (the Regional government, ATC 1 PG, and the Municipality) are struggling to respond to all citizens' requests, especially to raise awareness of the need for, location of, and results of culling operations.
In D14, the most decisive factor favoring the presence of wild boar is the strong interpenetration of agro-silvo-pastoral environments with the urban fabric. Perugia is a ridge town surrounded by valleys: the abandonment of farmland since the 1950s has transformed these areas into forests used by wild animals, including wolves and roe deer, as preferred routes of access and refuge. The necessary maintenance of public and private green spaces that are currently unmanaged (e.g., thinning, cutting, and reduction of shrubbery) is hampered by high costs and a lack of planning. Even policies to increase green spaces in urban environments never consider consequences such as the creation of conditions suitable for large Mammals to settle.
There is certainly a lack of events to raise awareness about the characteristics of wildlife management in urban environments that involve citizens as key stakeholders and that would encourage public acceptance and cooperation with regard to interventions.
From a One Health perspective, we need to move from greater or lesser collaboration and coordination between the bodies involved to a shared management plan. This means overcoming the 'buck-passing' of reporting and allowing the operators involved to pay greater attention to both regulatory and operational aspects for greater flexibility in interventions.
The possibility of an easily accessible meat supply chain (currently under development) and quicker resolution of issues for citizens would also reduce some of the obstacles to containment operations and transform them into current management events with positive implications for the health management of the species and the environment.

N. 30

easyViz: A new R package for base-graphics visualization of conditional effects in regression models

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Regression modelling is the workhorse of quantitative analyses in wildlife biology, where researchers routinely link distribution, abundance, demography, behavior and health indicators to intrinsic and extrinsic drivers. Yet, as models grow in complexity – through interactions, nonlinear terms, transformations, offsets and random effects – extracting and communicating conditional effects quickly becomes time-consuming. There are many great tools for plotting model results in R (effects, visreg, sjPlot, ggeffects…). easyViz adds to the list with a clear goal in mind: to provide a lightweight and intuitive workflow for producing statistically meaningful, publication-ready effect plots from a broad range of regression and mixed models, without requiring a new plotting grammar or extensive post-processing. It is particularly appealing for users who prefer base R graphics and want fine control through familiar plot() parameters. easyViz is implemented as a general-purpose R function that takes a fitted model, the original data frame, and the name of a focal predictor, then generates a prediction grid by varying the predictor (and optionally a conditioning variable) while holding all other covariates constant at user-defined values or sensible defaults (median/mean for numeric variables; mode/reference for factors). The function adapts prediction and uncertainty estimation to the model class, supports response- or link-scale output, and handles common ecological data structures such as binomial proportions and count models with offsets. For mixed-effects models, predictions can be conditional on random effects or marginal (population-level). Confidence intervals are computed using model-appropriate standard errors, with robust sandwich options for robust linear models. Plotting is performed exclusively with base R, and key visual layers (data, fitted effects, confidence bands and legends) are customizable through coherent argument naming. Across typical wildlife-analysis workflows, easyViz produces effect plots that match model specification while reducing the amount of user code and manual data wrangling required to obtain interpretable conditional predictions. The function supports linear and robust linear models (lm, rlm), generalized linear models (glm, glm.nb, betareg), generalized least squares (gls), nonlinear models (nls), Cox models (coxph), generalized additive models (mgcv::gam), and major mixed-model frameworks (lme4, glmmTMB). It can restrict predictions to observed ranges when requested, enables clear visualization of two-way interactions via conditional lines, and facilitates practical exploration of three-way interactions by combining conditioning with fixed-value settings. In addition to plotting, easyViz returns a tidy prediction data frame to support reporting and reproducible downstream workflows, and provides a concise conditioning summary that documents how covariates are held constant or varied across the prediction grid, facilitating diagnostic checks and transparent interpretation.
By lowering the barrier between model fitting and interpretation, easyViz helps wildlife biologists and practitioners move from numerical output to transparent ecological narratives, improving reproducibility and communication in reports, theses and management documents. Its emphasis on base graphics makes it particularly attractive for users who value compact, scriptable figures and fine-grained control without relying on a layered plotting language, and it is well suited for routine effect visualization, teaching and rapid exploratory analyses. The current version of easyViz (2.0.1) is available for download from CRAN.

N. 31

Mapping long-term monitoring schemes for mammals across the European Alps

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Alpine ecosystems are particularly sensitive to climate change and land-use modifications, making them among the most vulnerable environments globally. Mammal species exhibit diverse physiological, ecological, behavioural, and life-history traits adaptations to high-elevation habitats and occupy a wide range of ecological niches. This biological heterogeneity requires the implementation of species- and guild-specific monitoring schemes, based on distinct field methods and techniques.
Although some long-term mammal monitoring projects exist in the Alps, data remain spatially fragmented, with notable gaps especially at higher elevations.
Within the AlpsLife project framework, we (i) used an expert-based approach to select mammal species as indicators for the early detection of climate and land-use changes in alpine biodiversity based on Essential Biodiversity Variables (EBVs); and (ii) assessed the spatial coverage and temporal extent of long-term mammal monitoring schemes across the European Alps.
We conducted online surveys to collect quantitative and qualitative information on long-term monitoring projects with a minimum duration of 5 years, spanning multiple mammalian orders. Preliminary results indicate that several expert-selected indicator species are currently being monitored through long-term projects, especially within protected areas, such as national and regional parks. However, many small and medium-sized mammals remain underrepresented, highlighting the need to expand monitoring efforts, especially for species not listed under the EU Habitats Directive, which lack legal monitoring requirements despite high sensitivity to climate and land-use changes. Furthermore, substantial methodological heterogeneity persists across administrative regions, often preventing data harmonisation and integrated population assessments. This synthesis establishes a shared reference framework for systematically mapping and integrating available data, long-term monitoring protocols, and empirical evidence on Alpine mammal populations, with emphasis on high-elevation sentinel species. By facilitating efforts to enable comparable demographic assessments across the Alpine arc, this framework provides updated, practice-oriented guidance for stakeholders and land managers seeking to initiate long-term monitoring in regions where it is currently lacking.

N. 32

Occupancy shift or undersampling? Insights from a new record of *Myotis bechsteinii* in the Sibillini Mountains National Park

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In recent decades, citizen-science platforms (e.g., eBird, iNaturalist) have greatly increased the availability of species occurrence data. However, biodiversity knowledge remains affected by several shortfalls, which large-scale standardized monitoring programs can help address, despite their high costs and logistical constraints. In 2025, a national-scale bat monitoring program coordinated by ISPRA and funded by the Italian Ministry of Environment and Energy Security led to the first record of *Myotis bechsteinii* in the Sibillini Mountains National Park, where the species had never been documented before. Although *M. bechsteinii* is widespread in Italy, records from central and southern regions remain scarce. As a forest specialist relying on woodland habitats for both roosting and foraging, the species is of conservation concern given the ongoing loss and fragmentation of forests.
To assess whether this new record reflects a recent shift in site occupancy or historical undersampling, we compared the environmental niche of *M. bechsteinii* inferred from citizen science data with that derived from capture data collected through standardized monitoring. We used validated direct observations from iNaturalist and capture records from the national monitoring program, for a total of 24 occurrences. We assessed the environmental niche by using a principal component analysis (PCA) considering climatic and land-cover variables relevant to the species, namely the mean annual temperature, the precipitation of the warmest quarter, forest and water coverage. We downloaded at 30 arc-seconds resolution the climatic variables from the WorldClim dataset (v2.1) and land-cover variables from the ESA WorldCover dataset using the *geodata* R package. We estimated niche occupancy with kernel-smoothed density functions corrected for environmental availability, and niche overlap and divergence by visually comparing niche density distributions of both datasets in the PCA environmental space.
Capture data described a narrower and more conservative environmental niche, whereas citizen science data encompassed a broader range of conditions. The new record from the Sibillini Mountains fell outside the niche defined by capture data but within the environmental space described by citizen science observations. This suggests that the occurrence does not represent a shift into novel environmental conditions but rather reflects historical undersampling. Overall, our results highlight how different data sources capture complementary portions of a species' realized niche and underscore the importance of integrating long-term standardized monitoring with citizen science to improve species distribution assessments and conservation planning.

N. 33

Records of Golden Jackal (*Canis aureus* L.) in Aree Protette del Po Piemontese

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The golden jackal (*Canis aureus* L.) is an Euro-Asiatic species currently undergoing a strong expansion in Central-Western Europe. In recent years this wild Canidae has established stable populations in Northern Italy, as neo-native post-glacial invader. The first Italian chorologic record dated back to 1984, but the expansion of the little wild dog was very quick in Italian Peninsula, at present involving at least ten Italian Regions, South up to Latium ("Circeo" National Park, reached in 2020). Within the territory managed by "Ente di Gestione delle Aree Protette del Po Piemontese", characterized by high environmental heterogeneity and intense anthropogenic pressure, the presence of this species represents a phenomenon of particular conservation and management interest. This contribution reports records of golden jackal presence in the Piedmont Region, with a specific focus on the protected areas of the Piedmont Po River, aiming to describe temporal trends and the environmental context of the observations.
The data analysed were collected between 2020 the year of the first record, and 2025 and include direct observations, camera trapping records, and bio-acoustic monitoring. Each record was georeferenced and validated based on available information (number of individuals, observed behaviour, environmental context, and observers). The analysis was conducted in a descriptive manner, assessing the temporal distribution of records and the types of habitats involved.
During the study period, a total of six reliable records of golden jackal presence were collected, and three dead jackals were found. Most data originate from wooded riparian areas and ecotonal zones between natural and agricultural environments, often close to linear infrastructures and ecological corridors. Records mainly indicate the presence of dispersal youngs, suggesting an early phase of colonization, surely locally slowed down by high densities of wolves.
The results confirm the role of the Piedmont Po River protected areas as key elements for the expansion of the golden jackal, providing suitable habitats and ecological continuity within a highly anthropogenic landscape. The increase in records over time is consistent with patterns described in the European literature. Continued standardized monitoring is therefore recommended in order to assess population trends in the coming years.

N. 34

Ecological impacts and human-wildlife conflict of the expanding golden jackal (*Canis aureus*) in Friuli Venezia Giulia

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The objective of our poster contribution is to present a three-year project that will start in May 2026.
The recent expansion of carnivore populations throughout Europe has characterised both apex and mesopredator species. Whereas apex predator expansion and ecological effects are well documented, the ecological impacts of neo-colonising large mesopredators, such as golden jackal *Canis aureus*, remain poorly understood. Due to their high ecological plasticity and reliance on both wild prey and anthropogenic resources, jackals are increasingly associated with human–carnivore conflicts, particularly involving livestock. Effective conflict mitigation and management require robust population monitoring and a clearer understanding of trophic interactions among apex predators, mesopredators, and prey. Our project aims to examine how carnivore hierarchies influence species distributions, densities, and behaviours across different habitats and land-use types. Focusing on a wild canid community (grey wolf *Canis lupus*, golden jackal, and red fox *Vulpes vulpes*) in the region of Friuli Venezia Giulia (north-eastern Italy), the research will use two years of camera-trap data to (1) estimate species distributions and densities using occupancy and N-mixture models, (2) assess how wolf presence affects jackal and fox spatial, temporal, and behavioural patterns, (3) identify the most cost and time-efficient monitoring designs through power and cost analyses, and (4) evaluate and mitigate human-carnivore conflict risk by modelling conflict drivers and testing acoustic deterrents.
Camera traps will be deployed across representative habitats in the region over multiple years using a stratified sampling design. Occupancy and N-mixture models will be used to estimate population distribution and density of the carnivore species, and through mixed effects modelling we will compare spatial, temporal and behavioural patterns among species. Power and cost analyses performed on the model results will indicate the most efficient survey design for structuring carnivore abundance monitoring protocols. Population densities will be mapped across the region to analyse the risk of conflict based on livestock farming characteristics, and deterrent effectiveness will be evaluated.
We predict that in areas of established presence and high density of wolves, jackals will be suppressed due to competitive exclusion from wolves, increasing fox abundance through competitive release, but causing fox temporal avoidance of wolves. In resource-rich lowlands, wolves and jackals are expected to coexist at intermediate densities via habitat partitioning and greater vigilance of jackals, while in areas without wolves, jackal populations are predicted to increase and suppress foxes. In heterogeneous mosaic landscapes, abundant natural and anthropogenic resources are expected to reduce competition between jackals and foxes, facilitating spatial and temporal coexistence. Increasing human presence is predicted to drive greater nocturnality across all carnivores. Risk of human-carnivore conflict is expected to be highest near poorly protected livestock farms in wolf-free lowlands, characterised by large

herds of small to mid-sized livestock, with acoustic deterrents potentially offering temporary mitigation.
We expect that camera traps with attractants will increase the detectability of elusive carnivores, providing reliable multi-species abundance estimates and detailed information regarding species interactions. Our analyses will indicate the most time and cost-efficient sampling design for covering large and complex areas, and the most appropriate suite of models for monitoring carnivores. These results will help to develop multi-species monitoring programs that can be adjusted based on habitat, species, economic and logistical constraints. The aim of the project is to provide the first reliable estimates of carnivore populations in north-eastern Italy, the first study outlining the ecological interactions of a returning apex predator and neo-colonising mesopredator, and to create the foundation for efficient and reliable monitoring of these species in the future. Finally, we expect that our results will inform the development of effective strategies to mitigate human-carnivore conflict.

N. 35

Life after dark in the Belluno Dolomites activity patterns of carnivores under human disturbance

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Carnivores play a key ecological role in structuring terrestrial communities, yet detailed investigations of their activity patterns and behavioural responses to human disturbance remain limited, particularly in mountain environments subject to intense recreational use. Anthropogenic disturbance is often underestimated, despite its potential to profoundly alter temporal activity, movement patterns, and interspecific interactions. In the Monte Coppolo area (northern Italy), human and vehicular presence may induce shifts in activity rhythms and promote functional overlap among carnivore species as a result of behavioural adjustments to disturbance pressure.
This study investigated the activity patterns and temporal interactions of the carnivore community inhabiting Monte Coppolo, within the municipality of Lamon, assessing their relationship with anthropogenic and vehicular disturbance. Data were collected through a camera-trapping survey conducted across accessible areas of the mountain slopes. Camera-trap records were used to estimate species-specific activity patterns and to quantify temporal overlap between carnivore species using overlap coefficients (Δ) and associated statistical tests.
Overall, the observed activity patterns largely reflected the general ecological traits of the species investigated, while deviations from expected rhythms were detected and were likely associated with high levels of daytime human disturbance. Temporal overlap analyses supported the initial hypotheses, highlighting the influence of anthropogenic activity on circadian behaviour. The results further suggest the presence of behavioural adaptation mechanisms, including shifts in activity timing, that may reduce direct competition and facilitate coexistence among carnivores in a human-dominated mountain landscape.
This study contributes to a better understanding of how carnivore communities adjust their temporal behaviour in response to anthropogenic disturbance and provides insights relevant to the conservation and management of medium-sized carnivores in increasingly human-used mountain environments.

N. 36

Pellet-based long-term survey reveals multidecadal shifts in small mammal assemblages in the Regional Park of the Po Delta, Emilia-Romagna

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Small mammal communities are sensitive indicators of ecological changes within agricultural wetland landscapes, such as the Po Delta in Northern Italy. In this poster, we present the preliminary results of a long-term survey, comparing a substantial dataset derived from the osteological analysis of Barn Owl (*Tyto alba*) pellets collected between 1975 and 2000 in Punta Alberana (Anita, Ravenna)—located within the Po Delta Regional Park—with data obtained from pellets of the same predator collected at the same site during a new seasonal survey conducted in 2024–2025. This study aims to investigate temporal changes in the small mammal community structure and to assess how climatic factors and/or land use changes may have influenced species trends and dynamics.
Historical data obtained from the osteological collections of the Natural History Museum of Ferrara were digitized, taxonomically updated and standardized, and merged into a single database. Recent pellets underwent the same procedures to ensure consistency in the osteological analysis. Skeletal remains were identified at the Small Vertebrate Laboratory of the University of Ferrara, using a Wild stereomicroscope (6–50× magnification). To investigate potential long-term changes in diversity (richness) and dominance, prey community structure was analysed using four diversity indices: Shannon, Simpson, Evenness, and Berger-Parker. Mean monthly temperature and rainfall data (source: ARPAE) for the sampling years were included in Poisson GLMs to analyse the relative frequencies of each species. Integrating environmental variables with biological data in this modelling framework allows for a direct and standardized comparison of both historical and current small mammal assemblages."
Numbers indicate there is a strong negative temporal trend for *Microtus savii*, *Apodemus* (*Sylvaemus*) gr. *sylvaticus/flavicollis* ($p < 0.001$), *Sorex arunchi*, *Suncus etruscus* and *Mus domesticus*, suggesting that recent environmental changes have weakened the ecological stability of both humid-adapted and thermophilous/synanthropic taxa. *Microtus arvalis* has a long-term increase to become a major component of the local community and changing the overall community composition. Diversity metrics point out that there were greater evenness and richness in the 1980s, followed by long-term simplification of the prey community, where more recent samples indicate a decrease in diversity with a higher proportion being dominated by a few resilient taxa.
The integrated dataset provides a clear overview of the simplified structure of the Punta Alberana small mammal population. This trend can be attributed to the effects of climate change, the progressive loss of microhabitats that retain moisture and possess structural diversity, and the ongoing homogenization of the more general landscape of the Po Delta region. Considering the stability of the roosting site, the pellet collection is expected to continue, to increase the sample size and refine the temporal analysis, possibly also at a seasonal scale.

N. 37

Responses of small mammals to climate change in the Adige Valley bottom (Bz, Italy) during the early Holocene

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Small mammals are excellent proxies for environmental and climatic changes. Analyses of their bone remains recovered from archaeological stratigraphic sequences reconstruct past faunal communities providing insights into climatic adaptations (e.g., community turnover during warming/cooling phases). Early Holocene faunas offer baselines for modern climate change, reflecting post-glacial temperate re-establishment. We analysed archaeozoological remains from the Galgenbühel/Dos de la Forca rock shelter (Salorno, BZ; 225 m a.s.l.) inhabited by prehistoric hunter-gatherer groups, to reconstruct assemblage dynamics, the palaeoenvironment, and small mammal responses to climatic and environmental changes during the Early Holocene.
The site, 25 m above the Adige River on a detrital talus at the base of vertical dolomite faces, yielded radiocarbon dates spanning from approximately from 10.6 to 9.4 ka by present calibrated. The assemblage consists of 3,029 remains, yielding Number of Identified Specimens (NISP) of 3,019 and a Minimum Number of Individuals (MNI) of 570. The skeletal remains were recovered by water- screening sediments through 1 mm mesh sieves. Sorting and taxonomic identification were conducted at the Small Vertebrate Laboratory of the University of Ferrara, using a Wild stereomicroscope (6– 50x magnification). Identification relied primarily on diagnostic skeletal elements, while MNI was calculated for each stratigraphic level by counting the most frequent diagnostic element. To investigate diachronic changes along the about 2 m thick sequence, excavation units were grouped into five distinct phases; sub-phases were further identified within the first three. The analysis of assemblage evolution considered the entire sequence, while the ecological analysis of forest indicators was limited to its central part (phase 2a to phase 4, with sufficient sample size). According to Isotopic ($\delta^{18}O$) records from Greenland ice cores, this latter section of the stratigraphy should fall within the period between two cooling events that occurred at ~10.3 and 9.3 ka cal BP).
At least 10 taxa were identified. The distribution of relative frequencies highlights assemblages with little diversity, dominated by indicators of forest and aquatic habitat. Data suggest a widespread presence of lentic and lotic wetlands close to the shelter and extensive forest in the valley bottom and on the surrounding slopes, alternating with rocky areas in the steeper sections. The absence of thermo- xerophilic biological entities, fossorial species and other taxa that require dry soils, suggests a cool, highly humid forest. Forest indicators collapse at the top of the sequence, with dominance of aquatic species in the assemblage. Trends through the 2a and 4 stratigraphic phases of the sequence show increasing undergrowth vegetation species and decreasing open-rocky habitat ones.
The sequence is consistent with the climatic improvement that occurred between 10.3 and 9.3 ka cal BP, characterised by an increase in temperature and humidity and the consequent increase in forest density due to the expansion of mesophilic oak forests. In response to these environmental pressures, species associated with open spaces were replaced by those adapted to increasingly dense and humid forest environments. The collapse of forest indicators in the upper part of the stratigraphic sequence may reflect local flooding due to river dynamics, perhaps during a negative climatic oscillation, or a shift in the predators responsible for the accumulation of skeletal remains in the rock shelter (pending a taphonomic study).

N. 38

Looking into the blast holes

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Blast holes originate from an excavation technique still widely employed. Using rotary or hydraulic drills, a cylindrical hole—up to 2 meters in length and with a diameter of 40–60 mm—is drilled. Explosives are inserted into the hole and connected to a detonator, which triggers the explosion. After the removal of the fragmented material, the deepest portion of the hole is almost always preserved in the unexploded rock stratum.
In the Aosta Valley, where caves are scarce, abandoned mines and other artificial underground spaces offer alternative sites for bat hibernation. Our aim was to identify the species that, in the region, use blast holes to hibernate, and to quantify the frequency of such use in the mine of Pompiod (Aymavilles). This site—which we monitored for 34 years—is the most important hibernaculum known in the region in terms of number of species (N= 12) and number of individuals (up to 210).
We have carried out regular annual censuses of hibernating bats at Pompiod since the winter of 1992/93. From 2020, we have surveyed several additional artificial underground sites in the region, recording hibernating bats in seven other abandoned mines, as well as in the tunnels of two ancient irrigation channels and of the railway line Aosta–Prè-Saint-Didier (decommissioned in 2015).
Bats were counted and identified at a distance, using a binocular or a camera when useful. The only exception were five individuals from Pompiod, which were handled for taxonomic identification purposes during the early years of data collection, when it was important to clarify which species were present at the site in view of its inclusion in the Natura 2000 network.
Within blast holes, we recorded individuals identified as belonging to 10 species (*Barbastella barbastellus*, *Eptesicus serotinus*, *Hypsugo savii*, *Myotis myotis*, *Myotis crypticus*, *Myotis emarginatus*, *Pipistrellus kuhlii*, *Pipistrellus pipistrellus*, *Plecotus auritus*, *Rhinolophus ferrumequinum*) and to some species groups (*M. blythii/M. myotis*, *Pipistrellus* spp., *Plecotus* spp.).
We observed up to four individuals of Pipistrellus spp. per hole, and up to two individuals of H. savii. Only single individuals were observed for the other species.
Among the bats more frequently recorded at Pompiod, the use of blast holes was found to be frequent for *Pipistrellus* spp. (98.1% of N = 1283 observations, at least partially due to *P. kuhlii* and *P. pipistrellus*), *H. savii* (96.2%, N = 133), *E. serotinus* (91.3%, N = 23), and *B. barbastellus* (53.4%, N = 453). By contrast, it was uncommon in *M. blythii/M. myotis* (11.9%, N = 42; both species hibernate in the site) and sporadic in *R. ferrumequinum* (0.04%, N = 2180). Regarding the species more rarely recorded at the site, *Plecotus* spp. was observed in blast holes in 33.3% of cases (N = 12; some individuals were identified as *P. auritus*), *M. emarginatus* and *M. crypticus* were both recorded only once, with single individuals sheltered in blast holes, while the few observations of *R. hipposideros* (N = 4) concerned individuals hanging from the ceilings.
The data collected highlight the importance of conducting accurate inspections of blast holes during winter bat censuses, although these can be challenging. In the Aosta Valley this is particularly crucial for the monitoring of *B. barbastellus*, given its conservation importance.

N. 39

Large-scale monitoring and abundance estimation of the invasive coypu (*Myocastor coypus*) in Lombardy, Italy

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In Lombardy (Italy), the coypu (*Myocastor coypus*) has become one of the most damaging invasive alien species, having both economic and ecological impacts. It was introduced to Europe from South America in the 1930s for fur farming. Escapes and intentional releases allowed the species to spread widely, due to its high ecological plasticity and reproductive capacity. The impact of this species is severe in agricultural and wetland areas causing crop losses and threatening water and road safety through burrowing. In Italy, agricultural losses caused by coypu exceeded €11 million between 1995 and 2000. The species is regulated by the EU which requires its eradication or containment. These obligations are implemented through national and regional legislation. However management remains challenging due to the lack of updated abundance estimates and standardised monitoring protocols. The coypu population in Lombardy was estimated to be between 1–3 million in 2012-2013. This project aims to update the estimate of abundance of the species across Lombardy through a large-scale monitoring program. The monitored area focuses on lowland landscapes below 20 m a.s.l., particularly the Po Valley and adjacent plains, where coypu populations are most widespread due to a dense hydrographic network offering ideal conditions for their dispersal. For local abundance estimates, the study employs capture-mark-recapture (CMR) methods. Individuals are PIT-tagged and their age, sex, and body weight recorded. CMR provides the calibration baseline for indirect monitoring. From 2025 to 2027, indirect monitoring will use the active path count method along transects of approximately 3 km within 5×5 km grid cells. Double Observer (DO) surveys will be conducted to estimate detection probabilities and account for imperfect detection. During fieldwork, observers will record vegetation height, active paths, footprints, faeces, and direct sightings. These records will be analyzed with a Bayesian double-observer model. Calibration factors from CMR will be used to translate path counts into abundance estimates. By combining indirect indices, CMR estimates in sample areas and environmental layers, it will be possible to generate spatially explicit density maps highlighting gradients in distribution and abundance. The updated population estimates will enable comparisons between current and past abundance estimates. Preliminary results suggest considerable variation in coypu removals and cost-effectiveness, underscoring the need for standardized approaches to training, monitoring, and data collection that would improve control outcomes. The study aims to provide the necessary data to support the development of more effective, evidence-based management strategies aimed at safeguarding agricultural production, aquatic ecosystems and biodiversity in the long term.

N. 40

Enhancing and digitizing Italian theriological collections: a new open-access 3D database for the macroevolutionary study of eu-ungulates

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Natural history museum collections represent an irreplaceable archive of biodiversity, essential for understanding both past and present evolutionary patterns. In particular, the cranial morphology of ungulates preserves key information on behavioral strategies, such as dietary adaptations and anti-predator responses, which have been fundamental for the colonization of diverse environments. However, much of this heritage remains difficult to access or underutilized. This work presents an ambitious digitization project (funded by PNRR) aimed at creating an open-access 3D database of ungulate skulls preserved in major Italian museums (Roma, Torino, Firenze, Bologna, and Genova). By leveraging historical and chronological series—ranging from colonial era specimens to Italian endemic species, this database allows for a unique longitudinal perspective on how these mammals responded to past environmental pressures.

Sampling has involved the acquisition of over 350 specimens belonging to approximately 206 species, achieving 100% taxonomic coverage at the family level and nearly 65% at the species level. Notably, digitization has been completed for all Perissodactyla and for over 85% of the morphological variability within Bovidae. Data were acquired using digital photogrammetry (Agisoft Metashape) and laser scanning (Artec Spider), producing high-resolution 3D models with photorealistic textures.

The application of 3D geometric morphometrics to these models, through the placement of homologous anatomical landmarks, overcomes the limitations of traditional linear measurements by capturing the full complexity of cranial shape, enabling a deeper understanding of the plastic and evolutionary mechanisms that drive adaptation. This dataset has already enabled specific investigations into morphological variability and sexual dimorphism. Our analysis demonstrates that the richness and diversity of Italian museum holdings are comparable to major European networks, representing a strategic international resource for morphometric, evolutionary research, and for reconstructing the success of different behavioral and ecological strategies over time.

This project aims to establish a national collaborative network. We invite curators and researchers to contribute to this initiative to further expand the database, ensuring the digital preservation and global accessibility of Italy's theriological, specifically eu-ungulates, heritage, providing essential data to study how mammals adapt to rapidly changing environments.

N. 41

Less browsing, more seedlings: forest regeneration gains under reduced ungulate density

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Ungulate browsing can strongly limit seedling establishment and, consequently, affect forest regeneration processes. Here we assessed (i) the effect of ungulate access on seedling density by comparing transects open to ungulates with control transects excluding ungulates, and (ii) whether seedling density recorded along transects covaries with ungulate density estimated during the survey period. Seedling density (seedlings m^{-2}) was quantified along 35 transects uniformly distributed across the study area to capture vegetation heterogeneity and potential differences in browsing pressure among sub-areas of the San Rossore Estate (PI), Tuscany region. Transects were mapped and georeferenced and resurveyed from 2023 to 2025 following the same track; within each year, transects were walked during a single spring survey window (May–June), and seedlings were recorded within a 1 m belt on both sides of the transect to define a standardized sampled area and estimate density. Recorded seedlings were mainly tree/shrub species, dominated by *Quercus ilex* with recurrent occurrences of *Pinus pinea, Populus alba and Ulmus minor; Alnus glutinosa* was also recorded, and more sporadically Populus nigra and Quercus robur. In 2023, additional control transects with ungulate access prevented (exclosures) were surveyed within the same period to isolate browsing effects. Ungulate density estimates were derived from the annual spring monitoring program and projected to the post-birth period; to assign an ungulate density to each seedling survey date, an average daily population decrement rate was applied, accounting for natural mortality, management removals and wolf predation. The correlation analysis was restricted to open transects (n = 65 complete observations), while exclosures were used exclusively for the experimental comparison. Because data were not normally distributed, non-parametric approaches were used: the open vs exclosure comparison was tested with a Wilcoxon rank-sum test and quantified with Cliff's delta, and the relationship between ungulate density and seedling density was evaluated using Spearman rank correlation with a directional negative hypothesis. Seedling density was markedly higher in exclosures than in open transects (median 0.465 vs 0.0926 seedlings m^{-2}; Wilcoxon $W = 42$, $p = 0.0002868$), with a large effect size (Cliff's $\delta = -0.724$; 95% CI: −0.906 to −0.314), indicating a strong reduction in seedling density in the presence of ungulates. Across the full dataset (n = 65 observations), both seedling density and ungulate density deviated from normality (Shapiro–Wilk: seedlings $W = 0.641$, $p = 2.45\times10^{-11}$; ungulates $W = 0.673$, $p = 9.57\times10^{-11}$). Accordingly, Spearman correlation revealed a significant negative association between ungulate density and seedling density ($\rho = -0.270$; $p = 0.0149$; $\rho < 0$), indicating that higher ungulate densities are associated, on average, with lower seedling densities. Overall, the experimental evidence (exclosure vs open) provides robust support that ungulate access reduces seedling density, consistent with a top-down control of regeneration via browsing. The significant negative association between ungulate density during the survey period and seedling density further suggests that, where ungulate densities exceed locally sustainable levels, management measures aimed at limiting browsing pressure can facilitate seedling recruitment and thereby support forest regeneration, ecosystem resilience and the maintenance of key forest functions. More broadly, the need for active intervention is likely context-dependent and should be evaluated against local ungulate density and browsing intensity.

N. 42

Genomic approaches to investigate variability and local structure of the Italian wolf (*Canis lupus italicus*) population

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The rapid improvement of next-generation sequencing and the ever-increasing availability of new reference genomes made population genomic approaches applicable also to non-model species. Indeed, population genomics allows disentangling complex evolutionary histories and investigating diversity patterns, focusing on local adaptations which are fundamental to ensure population survival in the Anthropocene, characterized by increasing human pressures, environmental and climate changes. In this context, opportunistic carnivores, such as the gray wolf (*Canis lupus*), are recovering in human-dominated landscapes. The Italian wolf population (*C. l. italicus*), after severe demographic bottlenecks, is currently distributed in most of the Italian peninsula, though recent genomic studies suggest that the population is still susceptible to reduced effective population size, showing low genetic diversity, signatures of inbreeding, and signals of genetic load.
In this study, to deepen investigate the genomic diversity, population structure, and indications of wolf-dog hybridization, we generated 65 high-quality coverage whole-genomes from found-dead wolves retrieved from 2007 to 2024 across the entire Italian peninsula. The dataset was integrated with 35 genomes of dogs belonging to wolf-sized local breeds from a public database and 8 newly sequenced Italian village dogs. The obtained reads were aligned to the canFam3.1 dog reference genome and only autosomal chromosomes without multiple positions were retained. Quality filters for high call rates per SNP (>0.90) were applied removing loci with a minor allele frequency <0.05 and pruning for Linkage Disequilibrium. This resulted in a final dataset of about 1.2 million SNPs which was used to perform global ancestry inferences, followed by population and landscape genomics analyses.
Admixture and multivariate approaches identified 11 individuals with recent dog ancestry which were subsequently excluded from further population structure analysis. Clustering procedures revealed overall low levels of geographic differentiation across the peninsula, suggesting hight level of gene flow. Nevertheless, we detected a rough latitudinal north–south genetic gradient, suggesting geographic isolation or some possible local adaptations.
Future analyses on this highly representative Italian wolf whole genome database could allow to better investigate the possible presence of local adaptations and evaluate the real genetic status of the peninsular wolf population by estimating its effective population size and inbreeding levels, quantifying individual and population genetic load rates.

N. 43

Exploring the vertical dimension of forests: arboreal camera trapping for monitoring tree-living rodents

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Arboreal rodents play a key ecological role in forest ecosystems, yet they are often underrepresented in wildlife monitoring programs due to their elusive habits and predominant use of arboreal strata. In temperate forests, the vertical dimension of the canopy is rarely incorporated into study designs, resulting in a substantial knowledge gap regarding the presence, distribution, and ecological dynamics of these species. This study, developed within the R.A.MO.CA project "Roditori Arboricoli MOntagne di CAsalbuono", aimed to evaluate the effectiveness of an arboreal camera-trapping approach for monitoring tree-living rodent communities in temperate forests, with a particular focus on elusive native species and an expanding invasive alien species.

The monitoring design was based on the main forest types present in the study area and adopted a stratified sampling scheme suitable for estimating species distribution and applying occupancy models. An arboreal camera-trapping approach of the "selfie-trap" method was implemented, consisting of camera traps placed on wooden platforms positioned at different heights above ground (3–15 m), with the camera facing the tree trunk. This placement allowed the monitoring to be extended across the entire vertical profile of the forest. A food bait was placed in front of each unit to increase detection probability without significantly altering the natural distribution of the species.

The adopted approach enabled the detection of all arboreal rodent species present in the study area, including particularly elusive species such as *Eliomys quercinus*, which are rarely recorded using conventional monitoring techniques. Numerous records of the Finlayson's squirrel (*Callosciurus finlaysonii*), an invasive alien species currently expanding in the area, were also obtained, revealing a high colonizing capacity of all forest types present. Occupancy model analyses indicated high detection probabilities for the target species with a considerable number of records (*Muscardinus avellanarius, Glis glis, Callosciurus finlaysonii*).

The results highlight that arboreal "selfie-trap" camera trapping represents an effective and transferable methodological advancement for monitoring arboreal rodents in temperate forest environments. Explicitly integrating the vertical dimension of forests into sampling designs substantially improves species detectability and data quality, making this approach a promising tool for both the conservation of native species and the monitoring and management of invasive alien species within protected areas.

N. 44

Balancing risk and reward: red fox exploitation of wolf kills

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The recent recolonization of the grey wolf (*Canis lupus*) in the Alps has resulted in the presence of a top predator capable of generating predictable carrion resources through its kills. These carcasses may provide feeding opportunities for mesocarnivores, yet interactions at such shared resources can be complex ranging from antagonism to facilitation. In this study, we investigated how wolf kill sites influence mesocarnivore behaviour in relation to wolf activity, aiming to clarify the nature of these interactions. Specifically, we assessed whether foxes (*Vulpes vulpes*) exploited wolf kills, whether they exhibited temporal avoidance of wolves, and whether carcass and environmental characteristics influenced fox occurrence.
We analysed temporal interactions between red foxes and wolves at red deer (*Cervus elaphus*) carcasses in the southern sector of Stelvio National Park (Italian Alps). We included only carcasses confirmed to have been killed by wolves between November 2022 and December 2024 and deployed a camera trap at each carcass for 20 days. Fox presence–absence was modelled at an hourly resolution using binomial generalized linear mixed models incorporating wolf activity metrics, carcass characteristics, and environmental covariates. Wolf effects were quantified using four metrics: wolf presence within the same hour as fox detections, presence in the previous hour, time since the last wolf detection, and total minutes of wolf presence per hour. For each carcass, consumption status was assessed using an index reflecting the amount of biomass remaining ranging from unconsumed to almost completely eaten. Environmental characteristics of the surrounding area were also recorded, including forest cover, elevation, slope, aspect, and distance to main roads.
Foxes were detected at all monitored carcasses and showed predominantly nocturnal activity. Model selection indicated that fox presence was best explained by the simultaneous presence of wolves, with fox occurrence being positively associated with wolf activity within the same hour. Fox presence was also higher at carcasses with higher level of edible biomass, while no significant effects of vegetation structure, topography, or human disturbance were detected. Overall, foxes did not exhibit temporal avoidance of carcasses in relation to wolf presence.
Our results indicate that red foxes extensively exploit wolf-provided deer carcasses provided by wolves and tolerate close temporal overlap with this apex predator, suggesting that the energetic benefits of scavenging outweigh the risks associated with intraguild competition. Rather than exhibiting avoidance behaviour, foxes appear to capitalize on wolf kills as predictable food resources. These findings are consistent with a framework of trophic facilitation, suggesting that the grey wolf may act as an important source of carrion that indirectly influences mesocarnivore foraging behaviour and contributes to food-web dynamics in Alpine ecosystems.

N. 45

Detecting the genetic bases of anomalous coat colour patterns in Italian wolves and wolf-dog hybrids

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The rapid global climatic and environmental changes are significantly affecting the presence and distribution of numerous plant and animal taxa. Consequently, such phenomena might threaten the long-term survival of many local populations, especially for large carnivores, and increase the risk of anthropogenic hybridization with non-native or domestic taxa. For example, despite the overall demographic growth and range expansion of the European wolf (*Canis lupus*), anthropic activities and habitat modifications are prompting episodes of hybridization with domestic dogs in several populations, with potential introgression of dog-derived alleles which might alter morphology, fitness, and behaviour of the admixed individuals.
Since the 1980s, atypical coat colour patterns have been observed in the Italian wolf population (*C. l. italicus*), with cases of completely black, black-and-tan, black with white patches, and from-tawny- to-yellow individuals. However, when molecularly characterized using non-coding genetic or genomic markers, many of these animals did not show any sign of hybridization. Therefore, the analysis of functional mutations coding for specific phenotypes becomes fundamental to improve the detection power of possible signals of domestic introgression on morphology-related genes.
Thanks to the availability of a well-annotated reference genome, mutations on genes determining coat colour variations have been deeply characterized in dogs but poorly investigated in wolves, except for the 3-bp melanistic deletion at the β-defensin gene.
To verify whether the anomalous coat colorations observed in some Italian wild wolves are determined by dog-derived alleles or fall within the wolf individual variability, we sequenced the DNA of: six wolves/hybrids showing yellow coat, four showing black coat and kb deletion, five individuals showing black-and-tan colouration, eight white arctic wolves, and as reference eight wild- type Italian wolves, 11 Maremma Sheepdogs, nine white Samoyeds, nine white Swiss Shepherd Dogs, three yellow Labradors and eight yellow or white mongrels, at coding fragments of six genes (MC1R, ASIP, CBD103, MLPH, MFSD12, MITF) known to be pleiotropically interacting in the melanin production and pigmentation regulation.
Conversely to yellow Labradors, white Samoyeds, and white Swiss Shepherd Dogs, six yellow-coated wolves did not show mutations inactivating the melanin production, nor the melanistic deletion at β-defensin. However, four of them showed the dominant-yellow mutations at exon 4 of ASIP, as observed in four white Maremma Sheepdogs. Another two, both genetically classified as recently admixed wolves, did not have known yellow-coated mutations, and the five black-and-tan wolves did not possess the melanistic deletion; thus, other functional mutations might be involved in the expression of the observed, anomalous phenotypes. However, another five individuals showed no signals of dog ancestry, thus their anomalous phenotypes might fall within the natural intraspecific variation. Analysing whole genomes of wild wolves showing peculiar morphologies will surely contribute to better a) identifying the possible genetic bases of such untypicalities, b) disentangling the effects of domestic introgression from those of mutations falling within intraspecific individual variability, c) designing coat-colour mutation-specific primers to rapidly characterize even non-invasively collected samples.

N. 46

New insights into the distribution of the snow vole (*Chionomys nivalis*) in the Apuan Alps Regional Park

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The snow vole (*Chionomys nivalis* Martins, 1842) occurs in Italy throughout the Alpine range, with a fragmented distribution in the Apennines. Within the Apuan Alps Regional Park, the presence of the snow vole has been documented since the 1970s, with subsequent confirmations in the 1980s and casual observation in 2021. Remarkably, all historical and recent records within the Park have consistently referred to a single locality, namely the Passo del Vestito–Monte Pelato area, in the municipality of Seravezza. This apparent spatial restriction has long suggested the existence of a very small and isolated population. Indeed, several field surveys aimed at updating the checklist of small mammals within the Park, including live-trapping campaigns conducted in areas geographically distant from the historical site of occurrence, did not yield any captures of C. nivalis reinforcing the perception of an extremely localized distribution.
The present investigation was conducted between September and October 2025 within the framework of the project "Sampling of biological material from species of particular conservation interest for genomic sequencing biomolecular analyses," coordinated by the Consorzio Futuro in Ricerca (CFR, University of Ferrara) on behalf of the Italian Ministry for the Environment and Energy Security. Within the project, the field activities were specifically aimed at the snow vole, with the objective of collecting biological material suitable for high-resolution genomic analyses to improve knowledge of its genetic structure and conservation status. Fieldwork was based on the live capture of individuals using Sherman traps, followed by non-lethal tissue sampling in accordance with national guidelines for animal welfare.
Trapping sessions were carried out at two distinct high-altitude localities within the Park, Monte Pelato and Retrocorchia, separated by approximately 7 km in a straight line and differing in geomorphological setting and habitat configuration.
A total of eight snow vole individuals were captured during the survey period, with five individuals recorded at Monte Pelato and three at Retrocorchia. Trapping was conducted over a total of eight trap-nights, during two sampling sessions (23–27 September 2025 and 8–11 October 2025), resulting in an overall capture rate of 1 individual per trap-night. The detection of *Chionomys nivalis* at the Retrocorchia site represents the first confirmed record of the species outside its previously known distribution range within the Apuan Alps.
This new finding is of considerable relevance, as it provides evidence that the local population of the snow vole is not confined to a single site, as previously assumed. Given the interpretation of Apennine populations of *C. nivalis* as glacial relicts, the occurrence of the species in multiple localities within the Apuan Alps highlights the biogeographical significance of this mountain system as a potential refugial area. Moreover, these results suggest that the distribution of the snow vole within the Park may be wider and more spatially structured than previously recognized, possibly including additional suitable habitats that have not yet been systematically surveyed. A dedicated and comprehensive field investigation across the Apuan Alps Regional Park would therefore be required to refine current knowledge of the species' local distribution and to support future conservation and management actions within this portion of its Apennine range.

N. 47

Vertebrate Community Responses to the Vaia Windstorm: From Species Richness to Spatio-Temporal Behavioral Shifts

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Extreme weather events, such as windstorms, are among major forest disturbances and entail significant changes in ecosystem structures and wildlife population dynamics. Understanding community-level responses to such disturbances is vital not only for informed conservation strategies, but also to assess the potential drivers of disease dynamics. This study investigated the mid-term impact of the 2018 Vaia windstorm on the species richness, abundance and activity of vertebrate communities in the Paneveggio-Pale di San Martino Natural Park (Trento, Italy). Using a standardized camera-trapping design, we monitored two altitudinal levels: Val Canali (1.100 m a.s.l.) and Paneveggio (1.700 m a.s.l.). At each site, 20 camera traps were deployed for one-month in late spring of 2023 and 2024. By applying a control-impact design, we quantified species richness, relative abundance index (RAI), and spatio-temporal activities by comparing windthrow-affected ('Vaia') versus undisturbed ('no-Vaia') habitats.
Our findings indicated that natural disturbances enhance species richness by increasing environmental heterogeneity, providing novel refugia and foraging opportunities. Specifically, red deer (*Cervus elaphus*) and Alpine chamois (*Rupicapra rupicapra*) showed higher abundances in windstorm-affected sites, likely benefiting from increased resources from pioneer vegetation. Conversely, roe deer (*Capreolus capreolus*) abundance declined in these areas, suggesting a sensitivity to altered forage quality, habitat structure or new interspecific interactions with sympatric species. Habitat specialists, including martens (*Martes* sp.), hares (Lepus sp.), and grouse, remained strongly associated with undisturbed forests. Among carnivores, red foxes (Vulpes vulpes) were more frequent in Vaia-affected habitats, while wolves (Canis lupus) showed no significant spatial preference. Most species exhibited temporal niche partitioning, avoiding disturbed open areas during midday and peaking at dawn and dusk. This behavioral shift likely represented a trade-off between thermoregulation and foraging, while simultaneously being shaped by potential interspecific and human-wildlife encounters.
This study underscores the complex, species-specific responses of vertebrate communities to extreme weather disturbances, like the Vaia windstorm. These changes might have implications not only for ecosystem resilience, but also for public health related issues for the role that vertebrate communities play in disease dynamics. We argue that future monitoring must integrate biodiversity indices with systematic pathogen surveillance.
We acknowledge the Unione Nazionale Cacciatori Zona Alpi (UNCZA) for their support and for providing the essential technical equipment for this research.

N. 48

Population Density and Habitat Selection of Native Carnivores using CT-DS in the Rainforest of Anjozorobe-Angavo Protected Area, Madagascar

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The endemic carnivores of Madagascar, belonging to the family Eupleridae, are among the least studied carnivores worldwide. These unique species are facing escalating threats from rapid deforestation, prey depletion, and the spread of invasive species. Despite their ecological importance, critical data on their distribution, habitat use, and population density remain scarce, limiting the ability to effectively assess their conservation status and design targeted conservation strategies.
This study aimed to investigate the activity patterns, population densities and habitat preferences of native and non-native carnivores within the Anjozorobe-Angavo forest, a protected area characterized by a gradient of habitat degradation and human disturbance. Using 23 camera traps, we collected data over a five-month period (October 2024 to March 2025) along four transects, located at varying distances from the rainforest edge. For each camera station, we collected different vegetation, landscape, and anthropogenic variables, such as canopy cover and proximity to human settlements, to evaluate the effects of environmental covariates on species' detection probabilities. Density estimates were calculated using Camera Trap-Distance Sampling (CT-DS) models, while habitat selection was assessed using Generalized Linear Mixed Models (GLMMs), with camera stations included as a random effect.
Our survey identified four native carnivore species, for which we managed to obtain reliable density estimates: *Fossa fossana* (1.94 individuals/km²), *Galidia elegans* (0.31 individuals/km²), *Eupleres goudotii* (0.65 individuals/km²), and *Cryptoprocta ferox* (0.80 individuals/km²), as well as one invasive species, *Viverricula indica*. We also estimated their activity patterns, assessing a marked temporal segregation with F. fossana being strictly nocturnal, *G. elegans* strictly diurnal while *C. ferox* and *E. goudotii* were classified as cathemeral. The species showed some common habitat preferences, such as the utilisation of forest paths, as well distinct species-specific traits: *F. fossana*'s detection probability was higher near stream valleys with wide canopy coverage, *G. elegans* selected areas with higher understory coverage, *C. ferox* tended to avoid human settlements while *E. goudotii* showed high detectability near trails and forest edges. The invasive *V. indica* was almost exclusively detected in secondary forest patches, underscoring its adaptability to degraded habitats, while native species were predominantly observed in pristine forest areas.
Our findings underscore the severe effects of illegal logging and recurrent wildfires, which degrade primary forests and facilitate the spread of invasive species. By providing robust ecological evidence, this study advances our understanding of Madagascar's carnivore communities and offers new insights to inform conservation assessments and strategies, highlighting the urgency of integrated actions to mitigate anthropogenic pressures and ensure the long-term persistence of these unique species.

N. 49

Beyond the attic: movement ecology of *Myotis myotis* and *Myotis blythii*

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In South Tyrol, the sister species *Myotis myotis* and *Myotis blythii* form large and mixed maternity colonies, mainly occupying church attics during the reproductive season. While maternity sites are relatively well known and regularly monitored, connectivity among colonies has been poorly investigated and winter roosting sites remain unknown, limiting the identification of functional conservation units and hinder effective large-scale management strategies. Moreover, understanding how roosts are interconnected is crucial for defining epidemiological units and implementing targeted surveillance of pathogens with epizootic and zoonotic potential in a One Health framework. In this context, these colonies have been long monitored by the National Reference Center for Rabies based at the Istituto Zooprofilattico Sperimentale delle Venezie (IZSVe), following the detection of antibodies against the European bat lyssavirus 1 (EBLV-1). The aim of this study is to investigate the roost fidelity and the movement ecology of Myotis myotis and *Myotis blythii* in South Tyrol by integrating long-term monitoring using passive integrated transponders (PIT-tags) with Global Positioning Systems (GPS) tracking via Sigfox and landscape analyses.
We selected five of the nine mixed maternity colonies in the Autonomous Province of Bolzano (IT), representative of the geographical area and including largest aggregations. Since 2021, all individuals captured during lyssavirus active surveillance have been equipped with PIT-tags, which were checked annually during the reproductive period for existing TAGs and for PIT-tags using handheld antennas. In 2025, each colony site was equipped with Sigfox GPS reader antennas for monitoring. Furthermore, GPS Sigfox devices were deployed on 34 adult bats, from two roosts at the northern and southern border of the province. Devices were programmed with different acquisition schedules (e.g. 6 and 12 h) to record spatial fixes during nightly activity, commuting flights and longer displacements. GPS tracking data were preliminary analysed to define the daily roosting location; for fixes outside monitored colonies, landscape analyses were applied to identify potential unknown roosting sites.
Between 2017 and 2025, a total of 902 bats were tagged, and 55 individuals were recaptured or re-detected in subsequent years (6.1% recapture rate) across the five colonies. PIT-tag data indicated strong roost fidelity, with repeated use of the same maternity sites across years and only two movements detected between colonies. In contrast, GPS data revealed spatial movements beyond maternity roosts. Although no movements were detected between colonies equipped with antennas, individuals from both tracked colonies showed consistent directional movements away from the maternity site, with 45% and 30% of diurnal readings occurring at nearby roosts. However, this approach applies for the southern area only, where several roosts are already known. In the northern area, GPS data strongly suggest the presence of an unknown roosting site, however, the mountainous setting limits signal coverage and, in turn, the precision of the

outcome. Potential roosting areas were identified for future field verification, including churches and underground sites that may function as maternity, stop-over, or hibernation roosts. Overall, the combined use of long-term PIT-tag monitoring and GPS Sigfox tracking provides complementary insights into the movement ecology of *Myotis myotis* and *Myotis blythii*. While PIT-tag data confirm strong roost fidelity during the reproductive season, GPS tracking reveals broader connectivity patterns beyond maternity colonies. These preliminary results support a network-based interpretation of colony connectivity and highlight areas of interest for future surveys, and demonstrate the potential of integrating ecological and sanitary monitoring of bats within a One Health framework.

N. 50

What do roadkill data actually measure?

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Wildlife-vehicle collisions are a major source of mortality for mammals, and roadkill surveys are widely used to identify roadkill hotspots and guide mitigation planning. In most studies, the spatial distribution of recorded carcasses is implicitly interpreted as a direct estimate of roadkill risk. However, roadkill records do not measure mortality itself; they represent roadkill detection, i.e. a measure describing the spatial variation in the relative likelihood of detecting roadkills under current data constraints. It does not quantify the actual probability that an animal is killed on a road but rather describe the conditions under which roadkills are more likely to be observed and recorded. Roadkill detection is affected by carcass persistence, crippling bias, and observation bias. Consequently, the spatial pattern of detected roadkills may substantially differ from the spatial pattern of true mortality. Interpreting roadkill counts as risk therefore confounds an observation process with a biological process.

Roadkill data should be analysed within an explicit detection framework. Detection probability can be estimated through structured repeated surveys and modelled using approaches that separate mortality occurrence from observation, such as occupancy models. At the same time, roadkill risk depends on animal exposure to roads. Exposure is driven by species abundance and distribution, movement behaviour and landscape connectivity, which determine how frequently individuals attempt road crossings. Road-related variables such as traffic volume, vehicle speed, fencing and verge structure influence both mortality probability and roadkill detection. Reliable estimation of roadkill risk therefore requires the joint consideration of exposure and roadkill detection rather than reliance on raw carcass counts.

Empirical evidence from multispecies analyses indicates that road sections with many detected roadkills often correspond to permeable areas where animals frequently attempt crossings, but they may also be locations where carcasses are more easily detected. Conversely, road segments with few or no recorded roadkills may represent genuinely low-risk areas, segments particularly affected by roadkill detection bias, or barrier sections where animals rarely attempt to cross. As a result, hotspot identification based solely on carcass aggregation may misrepresent the spatial distribution of mortality and lead to incorrect prioritization of mitigation measures.

We propose a framework in which roadkill records are interpreted as detections of an underlying mortality process. Estimating true roadkill risk for mammals should integrate corrected roadkill observations, explicit estimation of roadkill detection probability, independent estimates of population abundance and connectivity analyses describing animal movement across the road network. Reframing roadkill data as an imperfect observation process allows more reliable identification of priority areas and more effective placement of mitigation structures, such as wildlife crossing. Reconsidering the definition of risk is therefore essential for improving conservation outcomes for mammal populations in roaded landscapes.

N. 51

Presence and distribution of the European wildcat (*Felis silvestris silvestris*) in the Serre Natural Regional Park (Calabria, Italy): preliminary data from camera trapping

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The European wildcat (*Felis silvestris silvestris*) is a protected species whose populations are threatened by habitat fragmentation, human disturbance, and hybridisation with domestic cats. In southern Italy, information on its distribution remains fragmented and incomplete. This study presents preliminary data on the presence and distribution of the European wildcat derived from camera trapping surveys conducted within the Serre Regional Natural Park, a protected area in Calabria (Southern Italy) characterised by high environmental heterogeneity and high conservation value. The study was carried out using camera trapping techniques during the period 2024–2025. The study area was divided into a 2 × 2 km grid cells, resulting in 14 standardised sampling units. Within each cell, one camera trap station was placed following a randomised positioning approach. Camera traps operated continuously, and the collected data were analysed to assess species presence and spatial detection patterns within the park. The European wildcat was detected at several sampling stations, confirming its presence in the study area. Detection events were mainly associated with forest habitats, characterised by low levels of human disturbance. Although population density could not be estimated, the results highlight areas with higher detection frequency and suggest habitat preferences consistent with those reported for the species in other Mediterranean contexts. In addition, a preliminary attempt at individual identification was conducted based on the analysis of camera trap images. These preliminary results confirm the importance of the Serre Regional Natural Park as a suitable area for the conservation of the European wildcat. The study provides a baseline for future monitoring activities and represents a first step towards more in-depth investigations into population dynamics, habitat use, and potential threats. The findings underline the value of systematic camera trapping surveys for improving knowledge of elusive species and supporting data-driven conservation strategies.

N. 52

They are what they eat: effects of diet on the gut microbiota of the gray wolf (*Canis lupus*)

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The grey wolf (*Canis lupus* L.) is undergoing a notable increase in population size and range across Europe, and the recolonization of peri-urban and agricultural areas may lead to dietary changes due to increased predation on livestock. Food intake allows the provision of resources necessary for the survival of both the host and its gut microbiota (e.g. bacteria, fungi, virus, helminths). Microorganisms adapted to live in the mammalian gut often have a mutualistic relationship with their host and contribute to the host's health and adaptive potential to environmental changes. Although well-studied in humans, the effect of diet changes on the gut microbiota of wild animals (including the wolf) living in human-impacted environments remains largely unknown. In this study, we investigated the effects of dietary shifts on wolf gut microbiota by analysing faecal samples collected with non-invasive methods from a pack of nine healthy wolves hosted by the BELPARK – Parco Faunistico Spormaggiore (Italy). Over a three-month period, wolves were sequentially fed a diet based on either whole sheep (*Ovis aries*) or roadkill (whole red deer, *Cervus elephas*) before returning to a conventional mixed diet. Faecal samples were collected daily from the wolf enclosure to capture short-term (i.e. within 48 hours) and mid-term (i.e. one to three weeks) responses of gut microbial diversity to each dietary change. Individual genetic identification of each sample was performed using a standard set of 10 microsatellite markers. Prokaryotic and fungal communities of 70 faecal samples representing the entire pack throughout the experiment were characterized using metataxonomy and targeting the prokaryotic 16S rRNA gene and fungal ITS2 region. To link taxonomic changes to changes in gut function, the gut microbial transcriptional profile of a subset of 20 samples was investigated using metatranscriptomics.

The wolf prokaryotic microbiota was rich in Bacillota, Bacteroidota and Fusobacteriota, phyla commonly found in carnivores gut microbiota, while fungal communities were dominated by Ascomycota. Longitudinal comparisons among individuals revealed a small core microbiota of dominant bacteria and fungi shared by all animals (109 bacteria out of 6,248 and 30 fungi out of 2,365), alongside a large number of low-abundance or individual-specific microorganisms (604 bacteria and 1131 fungi). Dietary shifts were associated with significant changes in the taxonomy of bacterial and fungal taxa. Notably, the transition from a domestic to a wildlife-based diet elicited contrasting responses: bacterial richness increased rapidly but transiently following dietary change, whereas fungal communities exhibited a continuous increase in richness and greater inter-individual variability. While fungal community composition was strongly associated with diet and differed significantly among dietary regimes, changes in bacterial community composition were only marginally linked to diet, a pattern increasingly observed in wildlife microbiome studies.

Our results delve deeper into the extent of natural variation through time of the gut microbiota hosted by related animals living in captivity and thus sharing a limited and controlled home range. These findings have direct implications for wildlife health and will contribute to the development of dietary regimes that preserve gut microbial diversity and functional potential, thereby supporting the welfare of animals housed in wildlife parks.

N. 53

Sex differences in behavioural responses to multiple stressors in two Alpine ungulates

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Mountain ecosystems are highly sensitive to environmental changes. Climate warming, increasing recreational activities, and the return of large carnivores across the Alpine range are among the main drivers that have been influencing these ecosystems in recent decades. Mountain ungulates are among the first species to be affected by these pressures and are expected to adjust their daily activity patterns in response to multiple stressors, which often act in contrasting directions and impose trade-offs between costs and benefits. Within populations, these trade-offs may vary substantially between sexes due to different ecological and reproductive requirements.
In the Gran Paradiso National Park, we investigated how temperature, predators, and human activity influence the activity rhythms of Alpine chamois *Rupicapra rupicapra rupicapra* and roe deer *Capreolus capreolus* in a sex-specific framework. Using an intensive camera-trapping effort (~16,547 trap-days across 72 sites) and fine-scale temperature data, we assessed variation in daily activity patterns and nocturnality of ungulates. The activity patterns of both ungulate species differed between the sexes. The presence of offspring during the summer months may increase female sensitivity to predation risk; across the entire sampling period, females of both species generally showed lower nocturnal activity than males, resulting in a lower spatiotemporal overlap with wolves compared to males. However, in female roe deer the probability of nocturnal activity was positively associated with human detection rates, which may be perceived as a highly threatening apex predator, leading females to shift activity toward nighttime. In contrast, male roe deer nocturnality increased with wolf detection rates, suggesting a possible synchronization of activity rhythms by the predator with the prey, potentially facilitated by reduced vigilance to predation during the breeding season, when males are actively engaged in territorial defence.
In female chamois, the probability of nocturnal activity was influenced by temperatures in the previous 24 hours: in particular, females increased their activity during nighttime following hotter days. The results show that behavioural responses to external stressors can differ between sexes, highlighting the need to explicitly consider sex as a key modulating factor when assessing behavioural responses to increasing stressors in Alpine ecosystems.

N. 54

Effects of seed mass on seed foraging behaviors of two sympatric rodent species

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Rodent seed foraging behaviour plays a key role in seed fate and plant regeneration. Seed mass is a central trait influencing seed predation, removal and caching by hoarding rodents. In ecosystems with multiple sympatric rodent species, differential seed use can exert varying selective pressures on seeds.
In a semi-natural experiment, we observed how *Quercus cerris* acorn mass affected seed predation, removal, and dispersal by two sympatric rodents of different body sizes, *Apodemus flavicollis* and *A. sylvaticus*.
For both species seed mass had a consistent effect in predicting seed fate. We detected a species-specific response in seed predation: *A. flavicollis* more likely predated heavier acorns, while seed mass was not found to affect acorn use in A. sylvaticus. Seed removal probability was affected by seed mass but it did not differ between the two species, which both showed similar removal patterns with respect to seed mass. Although the mass of removed acorns did not differ between the two species, the acorn mass to rodent body mass ratio of removed seeds was higher in *A. sylvaticus* compared to *A. flavicollis*. The likelihood of predation versus that of dispersal after removal was found to be species-specific: seed dispersal did not vary with seed mass for *A. flavicollis*, while *A. sylvaticus* dispersed heavier acorns.
These results suggest that the two species might play distinct roles in determining seed fate. Our findings highlight the importance of considering species-specific foraging strategies when assessing the role of sympatric hoarding rodents in seed dispersal and forest regeneration.

N. 55

The bat fauna of the ‚Bosco della Ficuzza, Rocca Busambra, Bosco del Cappelliere e Gorgo del Drago' Oriented Nature Reserve (Palermo, Sicily)

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Chiroptera represents the only order within the class Mammalia to have evolved the capacity for powered flight. Furthermore, the ability to emit ultrasound allows them not only to communicate but, above all, to echolocate obtaining information about the surrounding environment in low-light conditions or total darkness. These biological characteristics have enabled bats to exploit a wide variety of environments and colonize every continent, except Antarctica. However, despite their ubiquity, they are severely threatened by anthropogenic pressures, leading to population decline and fragmentation. Consequently, specific conservation regulations have been adopted to ensure their protection. This study, which was conducted in the ‚Bosco della Ficuzza, Rocca Busambra, Bosco del Cappelliere e Gorgo del Drago' Nature Reserve, focused on updating the local bat inventory and assessing the phenology of detected taxa across seasonal cycles. The objective of this study is to enhance conservation measures by updating the Standard Data Forms (SDF) of the Natura 2000 sites, incorporating the species detected, and providing relevant ecological and phenological information. A bioacoustic survey was conducted using AudioMoth (v1.1.0 and v1.2.0) passive recorders. Devices were deployed on a monthly basis over the course of a one-year sampling period. Recordings were scheduled for 2-3 consecutive nights, from one hour before sunset to one hour after sunrise, with recording windows adjusted to the seasonal photoperiod. The study area was subdivided into 500 x 500 m grid cells. Bioacoustic analysis was performed using BatSound v4.4.; for each sequence, three to five pulses were examined to identify the specific taxon. The spatial distribution of each species was mapped using QGIS, following data organization in Excel matrices. The frequency of occurrence was calculated for each species as the percentage of occupied grid cells. Seasonal variations in presence patterns were analyzed using Excel trend lines. A total of 12 taxa were identified, 10 of which were determined to species level and are listed as follows: *Plecotus* sp., *Myotis* sp., *Hypsugo savii*, *Pipistrellus kuhlii*, *Pipistrellus pipistrellus*, *Pipistrellus pygmaeus*, *Miniopterus schreibersii*, *Eptesicus serotinus*, *Tadarida teniotis*, *Rhinolophus ferrumequinum*, *Rhinolophus hipposideros* and *Rhinolophus euryale*. The frequency of occurrence for each species, calculated across 63 sampled grid cells, was as follow: *Plecotus* sp. (36.5%), *Myotis* sp. (38.1%), *H. savii* (79.4%), *P. kuhlii* (82.5%), *P. pipistrellus* (92.1%), *P. pygmaeus* (46.0%), *M. schreibersii* (76.2%), *E. serotinus* (27.0%), *T. teniotis* (82.5%), *R. ferrumequinum* (52.4%), *R. hipposideros* (28.6%) and *R. euryale* (3.2%). Phenological analysis indicated a general reduction in activity during the winter months. However, these patterns varied among taxa: *P. pipistrellus* and *H. savii* exhibited less marked seasonal fluctuations, maintaining a more constant presence compared to species such as *T. teniotis* and *P. pygmaeus*, whose trends appeared strictly seasonal. The remaining species exhibited intermediate patterns. The results of the study indicate high species richness within the Reserve. Spatial distribution analysis reveals the prevalence of generalist species, such as *T. teniotis*, *P. pipistrellus*, *P. kuhlii*, and *H. savii*. Conversely, the fragmented distribution of species such as *E. serotinus* and *R. hipposideros*, along with the localized presence of *R. euryale*, indicate greater ecological selectivity, designating these sites as priority areas for conservation. Furthermore, phenological data offer critical insights into activity periods of the detected species, which are essential for updating the Reserve's management measures. Evidence of distinct overwintering strategies underscores the need to update conservation measures, extending protection throughout the entire annual cycle.

N. 56

Assessing wolf *Canis lupus* breeding groups distribution within a protected sub-Mediterranean area: a case study from Terra delle Gravine, Italy

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The natural expansion of the Italian wolf (*Canis lupus*) into human-dominated sub-Mediterranean landscapes necessitates precise monitoring to inform conservation and management. In Southeastern Italy, the Apulia region serves as a significant case study, where the species has recolonized coastal and intensive agricultural zones over the last two decades. This study investigates wolf distribution and breeding group presence within the „Terra delle Gravine" Regional Natural Park, a unique karst landscape characterized by deep canyons (gravine) that function as a vital ecological corridor between the Lucanian Apennines and the Murgia plateau. Monitoring was conducted from March to September 2024 using a synergistic approach combining camera trapping and wolf howling surveys. Thirteen camera-trap sites were strategically established to ensure comprehensive sampling. Wolf presence was quantified using the Trap Rate (TR), defined as the number of independent detections per camera-operating hour (with independence set at a one-hour interval). To identify reproductive units and „rendez-vous" sites, 21 wolf howling stations were surveyed between July 24 and August 2, 2024. The total sampling effort amounted to 29,680 camera-trap hours, confirming wolf presence at 11 sites (≈85% of the sampled area). Out of 264 video clips, 214 independent detections were identified. TR values were generally low to moderate (TR≤2); however, significant activity (TR>2) was recorded at Gravina del Varco and Sant'Antuono wood, identifying them as regional hotspots. Based on juvenile detections and spatial-temporal overlap, four distinct reproductive events were confirmed. Notably high recruitment was documented at „Cristo Redentore–Masseria Tagliente" and „Gravina del Varco," with 5 and 8 pups recorded, respectively. Conversely, wolf howling yielded only two individual responses and no juvenile vocalizations, likely due to significant interference from domestic dogs and topographical masking. The results confirm that the „Terra delle Gravine" Regional Natural Park acts as a strategic stronghold for the wolf in the Apulian landscape. The unique geomorphology of the canyon systems provides „topographical shielding," offering high-quality refugia and denning sites isolated from anthropogenic pressure. This area serves as a biological source and a crucial stepping-stone for dispersal toward the Salento peninsula. The discrepancy between high camera-trap detection rates and poor howling responses highlights a methodological limitation related to the area's rugged morphology, suggesting that camera trapping is more effective for confirming reproductive success in karst environments. In conclusion, the refinement of monitoring protocols since 2016 has provided an accurate assessment of the species' status. Future management should prioritize the protection of these canyons as undisturbed corridors while fostering sustainable coexistence through support measures for local livestock farms, ensuring the long-term ecological integrity of this core regional area.

N. 57

One size does not fit all: a critical review of wild boar management and African Swine Fever (ASF)- driven policies in the Apulian region (Southern Italy)

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Historically, wild boar (*Sus scrofa*) management in Apulia has been characterized by fragmented governance. Systematic monitoring has been largely confined to specific Protected Areas, resulting in extensive portions of the territory lacking standardized ecological data. The emergence of African Swine Fever (ASF) prompted a paradigm shift, resulting in the regional implementation of national emergency frameworks, including the "*Extraordinary Plan for the Capture, Culling and Disposal of Wild Boar and Strategic Actions for the Development of Eradication Plans in ASF Restriction Zones 2023-2028*" and the "*National Action Plan for the Capture, Culling and Carcass Disposal of Wild Boar in ASF-Free Areas 2026–2028*". Since 2023, a coordinated regional response has deployed a large-scale monitoring programme based on standardized vantage-point counts to estimate Indices of Relative Abundance (IRA). These metrics were integrated with a region-wide assessment of compensated agricultural damage claims. Monitoring and management activities spanned a heterogeneous landscape, including National Parks, Regional Parks, State Nature Reserves (e.g., Alta Murgia, Terra delle Gravine, Lama Balice, Bosco delle Pianelle), and Hunting Districts. Population control was intensified through an integrated strategy combining traditional hunting, selective control, mechanical traps, and continuous-capture systems (Pig Brig). Based on "Criticality Classes" derived from swine farm density and historical statistics, the National Action Plan sets a regional target of 4,000 culls relying on socio-economic risk indicators as proxies for biological removal needs. Our analysis on Apulian data highlights a substantial "reality gap"; indeed, evidence from IRA values and damage trend analysis suggest that current abundance levels do not consistently justify the imposed culling quotas as observed ecological reality and spatially explicit damage data could be disproportionate in many instances. Wild boar management under ASF contingency requires greater scientific grounding and culling objectives should not derive solely from administrative criticality scores but must integrate robust, site-specific monitoring. In this perspective, it is essential that national and regional authorities systematically request and integrate data directly from local land management bodies (e.g., Protected Area authorities and Hunting Districts) to ensure that policies reflect the actual ecological status. Furthermore, effective ASF containment must move beyond a primary focus on population reduction. The present examined case in Apulia underscores the need to strengthen biosecurity measures through adaptive strategies. By balancing evidence-based management with reinforced, territorially differentiated biosecurity policies, ASF containment can become both ecologically sustainable and operationally effective wherever applied.

N. 58

Genetic insights into the Apennine brown bear: a decadal comparison

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Small and isolated populations are particularly vulnerable to anthropogenic pressures, which can amplify both demographic and genetic risks. The Apennine brown bear (*Ursus arctos marsicanus*) represents a paradigmatic case of long-term isolation within a largely human-dominated landscape. Understanding how genetic diversity and spatial dynamics change over time is essential to assess population resilience and inform effective conservation strategies within and beyond protected areas.
We genetically analysed 714 non-invasive samples collected during the 2025 population size estimation conducted within the DigitAP Project (PNRR), and 269 samples from the 2014 estimate, all including samples from a parallel long-term intensive monitoring program, using 17 microsatellite loci and the amelogenin gene for sex determination. Individual genetic profiles were used to assess genetic diversity, bottleneck events, inbreeding, effective population size, and individual occurences, enabling a temporal comparison between 2014 and 2025.
Results confirm extremely low genetic diversity, a very small effective population size, signals of inbreeding and bottleneck events, consistent with long-term isolation. No evidence of marked temporal deterioration emerged over the last decade, suggesting short-term genetic stability. In line with expectations based on female philopatry, spatial analyses revealed high male dispersal towards peripheral areas, whereas females showed modest yet detectable expansion beyond the historical core habitat. These findings represent a temporal snapshot based on two years of data and may not fully capture population dynamics, which should be interpreted in light of the continuous genetic monitoring time series and integrated with complementary approaches, including telemetry, counts of females with cubs, and field signs of presence. Despite short-term genetic stability and a clear range expansion, low genetic diversity keeps this population vulnerable to genetic erosion and inbreeding under ongoing human pressures. These results stress the need for long-term genetic monitoring using multiple approaches and targeted conservation to protect core habitats and improve connectivity.

N. 59

Metagenomic data unveil species-specific prey selection by bats in agroecosystems

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Insectivorous bats provide key ecosystem services including pest suppression and potential regulation of disease vectors. However, quantitative information on prey selection and functional dietary differences among European bat species remains limited, particularly in agroecosystems. Advances in DNA metabarcoding and functional analysis provide powerful tools to characterise bat diets at high taxonomic resolution and to assess their ecological and socio-economic relevance.
We analysed guano samples from 16 maternity colonies of six bat species in northwestern Italy. Diet composition was assessed using DNA metabarcoding of a COI gene fragment, followed by stringent taxonomic assignment and species delimitation procedures. Prey taxa were characterised based on eco-morphological traits and classified according to economic relevance, non-native status and disease-vector potential. Dietary differences among bat species were tested using GLMMs.
We identified 344 arthropod taxonomic units, dominated by Lepidoptera, Diptera and Coleoptera. Diets differed markedly in prey richness and size. *Rhinolophus ferrumequinum* showed the highest dietary richness and the broadest prey spectrum, while *Myotis emarginatus* had the most specialised diet, often including spiders. Mouse-eared bats (*Myotis myotis* / *Myotis blythii*) consumed the largest prey items, including non-flying ground beetles, consistent with a gleaning foraging strategy. Overall, 43% of prey species were of economic importance, including numerous agricultural and forestry pests, while 15% were non-native species. Twelve prey taxa were known disease vectors, mainly mosquitoes, predominantly consumed by *Hypsugo savii*, *Pipistrellus kuhlii* and *M. emarginatus*. Environmental variables did not explain dietary variation, highlighting intrinsic species-level differences in prey selection.
Our results reveal strong trophic complementarity among bat species and confirm their multifunctional role in agroecosystems, from pest suppression to potential regulation of non-native species and disease vectors. Integrating bat conservation into sustainable agricultural practices is therefore essential to maintain ecosystem services provided by bats under ongoing environmental change.

N. 60

Environmental Impacts of Alien Mammals in Italy: An EICAT Assessment

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Biological invasions by alien species in non-native regions have increased worldwide due to globalization and growing regional connectivity. Once introduced, alien species can exert severe impacts through a variety of different ecological mechanisms, threatening native species and ecosystem functioning. Notably, mammals are among the most invasive taxa globally. In Italy, alien mammal species have been introduced since ancient times and currently account for more than 10% of the national mammalian fauna, highlighting their ecological relevance at the national scale.
To assess the environmental impacts of alien mammals in Italy, we conducted a comprehensive review of the available scientific literature at the Italian level. From the collected data sources, we extracted information documenting the impacts associated with the targeted alien species. All impact records were systematically evaluated using the Environmental Impact Classification for Alien Taxa (EICAT), a standardized framework that categorizes impacts according to their magnitude and the underlying ecological mechanisms.
Our results indicate that grazing/herbivory/browsing (38.2%), competition (25%), and predation (19.7%) were the most frequently reported impact mechanisms, primarily inferred from dietary studies. Most impacts were classified as Minimal Concern (MC) or Minor (MN), generally affecting native species at the individual level. However, several alien mammals, such as *Procyon lotor* (MR), *Sciurus carolinensis* (MR) and *Rattus rattus* (MO), were reported to cause severe impacts at higher levels of biological organisation, underscoring the need for targeted management and conservation actions.
Overall, the limited number of sources identified in the systematic review reveals a substantial lack of knowledge on the ecology of alien mammals in Italy. Nevertheless, despite these limitations, this study highlights a wide range of their ecological impacts, with particular attention to the species causing the highest impacts. Standardized EICAT assessments provide insights into impact magnitude and mechanisms, offering a valuable basis for future research and management planning.

N. 61

First assessment of Eurasian beaver distribution in Central Apennines

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The Eurasian beaver (*Castor fiber*) appeared in Central Apennines after unauthorised reintroductions. Since its first spotting between 2021 and 2023, the knowledge about the conservation status of this semi-aquatic mammal in Abruzzi region has not advanced, nor any further new records have been received. We present the results of systematic sampling conducted within a large portion of the upper Pescara River basin, to confirm the species' presence survival and possibly define its distribution. We conducted 67 transects walking along riverbanks to search for fresh and old presence signs. A canoe was integrated to comprehensively monitor the banks of a highly suitable area. Finally, five camera traps were also deployed, evenly distributed along the river network, and then repositioned close to possible fresh beaver signs noticed to define a minimum number of individuals. Signs of a non-recent beaver presence have been found along the middle stretch of the Aterno river, where the first records of this species were collected. Recent signs of presence have been observed along the Peligna Plain. Camera trapping activities have led to the acquisition of two videos of beavers. The distribution of recent signs is concentrated in a small area and suggests a small and sparsely distributed beaver population, that does not appear to have increased in size till now. Further investigations in the future may shed light on the fate of this little isolated population.

N. 62

Eurasian otters slowly recovering in central and northern Italy after 40 years

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Once widespread across the Italian Peninsula, the Eurasian otter dramatically declined during the 1970s, persisting only in a few river basins in southern Italy. Following legal protection and the ban of harmful pollutants by the European Union, in the early 2000s, the species has gradually re-expanded into parts of its former range, although large portions of central and northern Italy still remained unoccupied. Forty years after the first national survey, WWF Italia coordinated a new large-scale collaborative survey in 12 regions of central and northern Italy, where the otter was considered extinct or few recent records needed to be confirmed. Between May 2022 and December 2023, we surveyed 651 10x10 km grid cells (ETRS89 LAEA projection) across 38 river basins located either i) close to the current distribution of the species in neighbouring regions; ii) within the historical occurrence of the otter in the region, or iii) where otters have been recently spotted, recorded, or road killed. One site per cell was selected using an expert-based habitat suitability model developed from available inferential models. Surveys followed the standard IUCN/SSC Otter Specialist Group methodology. Otter signs were detected in 65 cells (10%), indicating the return of the otter in Latium, Marche, Liguria, Veneto, and northern Lombardy close to the Swiss border. A further expansion in new river basins was recorded in Friuli Venezia Giulia and Alto Adige. Despite recent isolated records, Umbria, Piedmont, Tuscany, Emilia Romagna, and Valle d'Aosta seem to be still largely avoided of stable otter populations. Accordingly, in central and northeast Italy otter distribution remains highly fragmented, highlighting the need for continued monitoring and strengthened protection of riverine habitats and ecological corridors.

N. 63

Weekend overload: day-to-day fluctuations of human frequentation affect wild mammals' space-use in a popular forest reserve near Florence, Italy

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Natural and protected areas are increasingly used for outdoor recreation, with potentially negative consequences on wild mammals. Human frequentation can be particularly concentrated during short periods, like weekends, especially in natural areas close to urban settings. Peaks of human presence could generate acute disturbance to wildlife, potentially affecting their temporal activity patterns or spatial distribution. To date, little evidence is available on the "weekend effect" on mammals and current community-level research focuses only on their temporal responses. Here, we tested the spatial and temporal distribution of the medium-to-large wild mammal community in relation to day-to-day fluctuations of human presence occurring between working days and weekends. We deployed 52 camera-traps systematically within an EU Natura 2000 area located within the metropolitan area of Florence, central Italy, during September – November 2022. We estimated that human frequentation significantly peaked during weekends and holidays, while mammals' site-use was generally lower. Eight out of ten mammal species seemed to spatially modulate their use of space to the fluctuations of human presence, both in relation to the rate of human passage and the proximity to roads. Conversely, we found no evidence of significant differences in temporal activity between mammals and humans during working days and weekends, as the temporal overlaps were generally low during both day types. Thus, spatial modulation of site use seems the most used short-term strategy to cope with bouts of high human frequentation, with the temporal avoidance that may enable the longer-term tolerance of humans without preventing the use of preferred habitats.

N. 64

The impact of invasive alien species: Pallas's squirrel debarking in Varese province

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Invasive species are one of the greatest threats to biodiversity. They can compete with native species, forcing them into suboptimal areas or driving them to local extinction. Alien species can also impact ecosystems by altering their structure and functioning, although such damage is often difficult to monitor. In this project, we monitored tree damage caused by Pallas's squirrel in Northern Italy. Members of the family Sciuridae are known to be problematic due to their tendency to debark trees. For example, damage caused by the grey squirrel (*Sciurus carolinensis*) to *Quercus* spp. and *Fagus sylvatica* plantations is well documented in Great Britain. The Pallas's squirrel (Callosciurus erythraeus) is considered a threat to the timber trade in Argentina and to forest ecosystems in Japan. In Italy, the variable squirrel (*Callosciurus finlaysonii*) causes damage through bark stripping in its area of introduction.
The only Italian population of Pallas's squirrel is found in the province of Varese, Northern Italy, near the Swiss border. Since 2011, this population has been controlled as required by EU Regulation 1143/2014. In this area, there are no commercial timber or fruit plantations; however, bark-stripping damage occurs in natural forests. The main habitat consists of broadleaved forests dominated by chestnut (*Castanea sativa*), beech (*Fagus sylvatica*), and the invasive black locust (*Robinia pseudoacacia*). Other important species include hazel (*Corylus avellana*) and European holly (*Ilex aquifolium*). This study aims to determine whether certain tree species are more susceptible to squirrel debarking and whether common patterns exist among bark-stripped trees.
Our results clearly demonstrate that some tree species are positively selected by Pallas's squirrels, while others are avoided relative to their availability. *Ulmus spp*., *Acer spp*., and *Tilia cordata* were the most strongly selected species, despite not being dominant in the area. In contrast, many species were completely avoided and never damaged by squirrels (for example *Betula pendula* and *Quercus spp*.). At present, there is no clear biological evidence explaining species selection. It remains unclear why certain species are preferred over others, but we hypothesise that tree secondary metabolites may influence squirrel selection.
Although bark stripping rarely leads to tree mortality, it can still affect plant growth and health. Strong selection pressure exerted by squirrels on certain species could influence forest structure and overall forest health in the future. This, in turn, may lead to changes in ecosystem structure and functioning. Damage caused by bark stripping by invasive squirrel species is often studied in relation to plantations and the timber trade, and only rarely in natural environments. A better understanding of this mechanism could help identify priority areas for forest ecosystem conservation.

N. 65

Adaptation at the dinner table: badger diet in urban and sub-urban habitat

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Urbanisation influences biodiversity, driving some species to local extinction while promoting behavioural adaptations in other taxa. Many medium-sized carnivores are well adapted to urban life due to their generalist habits. Nowadays, the European badger (Meles meles) is second only to the red fox (Vulpes vulpes) among the most common mesocarnivores in urban habitats. In this environment, the species' wide trophic spectrum may greatly favour its presence. Badgers may feed on different trophic resources depending on their spatial and temporal availability.
The diet of badgers was studied in an urban area within the city of Varese and in a sub-urban site, characterised by a typical rural landscape located 17 km from Varese (northern Italy). A minimum of 12 faecal samples per site were collected for each of the four seasons, between June 2024 and February 2026. Samples were analysed by washing them through sieves and subsequently identifying undigested remains. From these remains, the frequency of occurrence of each food item was calculated and the ingested volume of different resources was estimated. These data were used to calculate trophic niche breadth (Shannon index) and dietary overlap (Pianka index) for comparisons between sites.
A total of 114 samples were included in the analysis. Our results suggest that badgers in both study sites exploit resources according to their spatial distribution and temporal availability, also making extensive use of plant-based foods derived from human activities. This food source is clearly favoured in urban areas. Overall, trophic niche breadth in the urban area was narrower than in the sub-urban area (Shannon index = 1.31 vs 1.51), although dietary overlap between the two sites was high (Pianka index = 0.85). Food items spectrum varied seasonally in a similar manner at both sites, with the exception of summer, when the number of food items was lower in the urban area. Moreover, through calorimetric evaluation, we investigated seasonal energy intake to assess whether differences exist between the two sites.
Studying the diet of urban badgers is important for better understanding how the species adapts to human-modified habitats. This information can contribute to the development of appropriate management strategies for green areas in cities. Our study highlights the extensive use of human-related resources and suggests that the presence of this species in urban centres could become a permanent feature in the future.

N. 66

First assessment of trace elements in tissues of two Eurasian otters (*Lutra lutra*) from northern Italy

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Eurasian otter (*Lutra lutra*) has been widely studied as a sentinel for aquatic ecosystems health and is considered a flagship species. Habitat deterioration, anthropogenic disturbance, human persecution and pollution led otter populations to a progressive decline, making the species endangered for the Italian IUCN list. As an apex predator, Eurasian otter can accumulate inorganic contaminants through its diet, resulting in biomagnification over time. Therefore, many ecotoxicology studies focused on this species to assess the presence of toxic substances and trace elements (which may be essential but have been shown to be harmful if excessive) in individuals and in freshwater environments.
In this case study we report trace elements levels detected in tissues of two otters from Aosta Valley. These individuals, sourced from the European Endangered Species Program (EEP), were kept in semi-captivity in the centre "Acqua e Biodiversità" of Gran Paradiso National Park. After death (in 2021 and 2024), they were conferred to Istituto Zooprofilattico Sperimentale del Piemonte, Liguria and Valle d'Aosta (IZSPLV) for necropsy and sanitary controls. Kidney and liver samples were collected from National Reference Centre for Wildlife Diseases (CeRMAS) and have been sent to the laboratory for Inorganic Contaminants of IZSPLV, for the detection of 9 elements (As, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn). Samples were subjected to microwave digestion with 7 mL of HNO3 (70% v/v) and 1.5 mL of H2O2 (30% v/v). Multi-elemental determination of the elements was performed using ICP-MS Agilent 7800. The quantification limit (LOQ) for all elements was 0.010 mg/kg. Results were compared to those observed in otter from southern Italy and to those reported in literature.
Analysis led to the following results: toxic metals (As, Cd, Cr, Ni, Pb) were detected in all the samples but in low concentrations. The otter dead in 2024 exhibited lowest kidney and liver levels for all the toxic metals compared to the otter sampled in 2021. Essential metals (Cu, Fe, Mn, Zn) show the same trend, with higher concentration in the individual of 2021. All the values were consistent with physiological levels, except for high Pb concentration in the otter of 2021 and generally low concentrations of Mn for both the animals.
Results confirmed the presence of all the metals in both otters, with a general decrease over the years. Cd, Cr and Pb show a considerable reduction in 2024 in both kidney and liver, suggesting either improved environmental conditions or reduced exposure through diet. However, all toxic metals were detected in lower or consistent levels compared to those observed in otters from southern Italy and reported in literature. This also applies to most essential metals. Mn kidney and liver levels were lower than those observed in otters from southern Italy but align with values observed in *L. lutra* from Finland and in *L. canadensis* from Canada. By contrast, Fe levels in the otter of 2021 are higher than those reported in literature even for other mustelids.

Fe is involved in numerous metabolic and self- regulatory processes, so concentration in animal tissues generally does not reflect its content in the environment. High values rather suggest a stress condition caused by pathologies, inflammations or an atypical diet. Indeed, analyses on this otter pointed out a gallbladder tumour extending to the liver, which could possibly be the cause. Although two individuals cannot be representative of otter alpine population or semi-captivity conditions, these analyses are the first data results of trace elements concentration in tissues of *L. lutra* from northern Italy and can be considered for future analyses and comparisons. Lastly, metal levels detected in this study indicate good environmental conditions, confirming otter's role as a sentinel species for freshwater ecosystems.

N. 67

Sharing the slopes: How winter recreation influences the behaviour of mountain ungulates in the Italian Alps

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The Alps are undergoing rapid climatic, ecological and socio-economic changes. Mountain ungulates, key prey and game species, are exposed to pressures that can alter their behaviour across spatiotemporal and social scales. Outdoor recreation has become a recognised source of disturbance, with studies reporting predominantly negative behavioural impacts. The growing tourism industry, expansion of trail networks, and infrastructure, as well as the rise in popularity of outdoor activities, now overlap more frequently with mountain ungulate home ranges, potentially challenging their conservation and management. Existing knowledge on the impact of outdoor recreation is predominantly focused on the summer season, and particularly hiking. However, winter recreation remains understudied, despite indications that snow-based activities can strongly affect behaviour and movement in other species (e.g., Tetraonids). Filling this knowledge gap is crucial, given that winter is a period of cold temperatures, reduced forage availability, increased energetic demands, and limited habitat options for many species.
We addressed this issue by empirically assessing the behaviour of mountain ungulates in a ski resort area in the Central Alps (Val di Peio, northwestern Trentino, Italy), where in winter 2025/26 we set up a grid overlapped with the ski slopes. We deployed one camera per grid cell (0.5 x 0.5 Km) opportunistically on trails, along a gradient of distance from the closest ski slope. In addition to the camera traps, we also deployed audio recorders (Song Meter Micro 2, Wildlife Acoustics) in six cells at various distances from ski slopes to record human noise (anthropophony). We evaluated the impact of human disturbance on the distribution, activity patterns, group size, and demographic dynamics of mountain ungulates in the ski resort. Specifically, we measured the level of disturbance based on a combination of detailed spatiotemporal information of the intensity of use of the ski resort (e.g., accesses recorded to each lift) and the acoustic index of human pressures, as measured by sound recorders.
Overall, by applying Generalised Linear Mixed Models (GLMMs), we found that the behaviour of mountain ungulates is neither positively nor negatively affected by human disturbance. However, the animals locally avoided peaks of disturbance by adjusting their activity patterns and occurrence, thereby reducing their spatiotemporal overlap with anthropogenic pulses of disturbance.
Our findings suggest that behavioural flexibility may allow mountain ungulates to persist in a human-dominated landscape. We believe that the lack of an overall response is likely due to the habituation to chronic disturbance at the ski resort. Furthermore, the south-facing location of the ski resort results in an overlap with some of the most suitable overwintering areas for these species. Consequently, mountain ungulates may tolerate the costs associated with disturbance given the advantages of remaining in areas where environmental conditions are favourable (e.g., reduced snow layer depth). However, it is not yet known whether this comes with any fitness costs.

N. 68

Biogeographic analyses of *Clethrionomys* sp. in Bogd Khan strictly protected area in Mongolia

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Ulaanbaatar, Mongolia's capital, hosts nearly half of the country's population and is undergoing rapid urban expansion, gradually replacing traditional nomadic and pastoral practices. The Bogd Khan Strictly Protected Area (SPA), bordering the southern edge of the city and acting as a natural barrier to urban growth, faces increasing pressure from livestock grazing and surrounding urbanization. These combined pressures may affect local ecosystems at multiple levels, including small mammal communities, and may also influence intraspecific genetic diversity by increasing habitat fragmentation and isolation, thereby limiting gene flow. Because genetic diversity underpins population viability and adaptive potential, and genetic structure can serve as a sensitive indicator of changing connectivity, genetic data from indicator species, such as voles, are highly relevant for conservation planning within protected areas. But to this date no previous genetic studies have been conducted on rodents in this SPA. This study aims to assess genetic diversity, population structure, and demographic history of *Clethrionomys* species within the SPA.

Rodents were sampled using a capture–mark–recapture approach, with hair samples and biometric data collected from each individual. A total of 47 samples were obtained from two locations within the SPA (Areas A and B). A fragment of the mtDNA cytochrome-b was sequenced in both directions, and the species was molecularly identified via BLAST due to the challenges of correct taxonomic identification in the field caused by overlapping morphological traits between *Clethrionomys rutilus* and *C. rufocanus*. Genetic diversity, population structure, and phylogeographic patterns were then investigated for the two identified species (*C. rutilus* and *C. rufocanus*) separately.

The 47 individuals sampled were divided into 37 *Clethrionomys rutilus* and 10 *C. rufocanus* with both species being present in the two areas. In *C. rutilus*, genetic diversity was higher in Area A (Hd = 0.97, π = 0.014) than in Area B (Hd = 0.85, π = 0.010). Genetic differentiation between areas was low and non-significant (FST = 0.0063), indicating substantial gene flow. Thirteen haplotypes were identified in Area A and 11 in Area B, with four shared haplotypes. The haplotype network analysis exhibited a star-like structure, consistent with recent population expansion, hypothesis supported by negative Tajima's D and Fu's Fs values. In contrast, 9 haplotypes were obtained for *C. rufocanus*, with no shared haplotypes between the two areas and high overall haplotype diversity (Hd = 0.97). Nucleotide diversity was higher in Area B (π = 0.021) than in Area A (π = 0.006), with moderate genetic differentiation between areas (FST = 0.05), although sample size was limited.

Molecular identification provided reliable species identification and showed a clear taxonomic differentiation between the two species. Additionally, the two species seem to have had different

demographic histories, with *C. rutilus* showing signs of a recent population expansion, which matches the neutrality tests, whereas *C. rufocanus* likely experienced limited gene flow, although the small sample size requires caution. While *C. rutilus* showed evidence of gene flow between areas, *C. rufocanus* displayed greater genetic differentiation, possibly linked to habitat differences. Future research should focus on morphological variation and habitat selection to improve species identification and investigate ecological requirements of each species. Such research could also inform conservation strategies aimed at preserving suitable habitats and limiting the environmental impact of livestock, whose growing presence threatens the ecological integrity of the Bogd Khan Strictly Protected Area.

N. 69

Islands in the desert: conservation genetics of the Nubian ibex (*Capra nubiana*)

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Nubian ibex (*Capra nubiana*) is a desert-dwelling species, adapted to hot and arid environments. Once widespread across the mountainous regions of northeastern Africa and the Middle East, it is currently listed as Vulnerable on the IUCN Red List, following a substantial range contraction. The species now persists in small, isolated, and fragmented populations, with an estimated global population of fewer than 5.000 mature individuals. Major threats include habitat loss due to agriculture and livestock (with associated hybridization risk), infrastructure development, hunting, pollution, and competition with non-native species. Despite ongoing conservation efforts, including reintroductions and captive breeding, the source populations of translocated individuals are often poorly documented. In the present study we focus on one of the captive populations to investigate its potential origin and genetic diversity to support breeding and conservation strategies.

We collected tissue samples (ear punches; N = 7) during the handling of Nubian ibexes translocated from Jordan to a fenced, semi-captive area on the eastern side of the Shouf mountain range (Lebanon), identified as suitable after a previous feasibility study. Samples were genotyped with the goat 50K SNP chip and compared with available Nubian ibex genotypes (Egypt N = 2, Israel N = 1, Saudi Arabia N = 1, South Africa N = 1, Sudan N = 7) to assess genetic variability and potential origin, and with domestic Nubian goats (N = 10) to ascertain potential introgression from domestic goats. To account for the bias in the chip design, targeted at domestic goats, we filtered the autosomal SNPs of Nubian ibex for quality and minor allele frequency in plink1.9, and later extracted the same markers from the domestic population. We used adegenet to perform a Principal Component Analysis (PCA), the same package and dartR to calculate genetic variability, detectRUNS to estimate inbreeding, plink1.9 to assess kinship and sambaR to determine FST and population structure.

The Lebanese population had high levels of polymorphism (64%, range 12% – 64%) and comparatively high levels of observed (Ho = 0.21) and expected (uHe = 0.20) heterozygosity (range Ho: 0.12 – 0.24, uHe: 0.12 – 0.24). The PCA showed a clear differentiation of the domestic and Sudan populations, while the Lebanese cluster was separate but closer to the other Nubian ibex. This result was only partly supported by FST values that were moderate (0.28) between the Sudanese, that otherwise showed high level of differentiation (0.43 – 0.49), and Lebanese population. The latter population had similar values (0.21-0.25) with the other wild populations but higher FST with Nubian goats (0.38). The cross-validation of the ancestry analysis identifies K = 2 as the most likely subdivision into clusters, differentiating ibex from goats and identifying a hybrid individual in Lebanon. All Nubian ibex were inbred (FROH 0.030 – 0.053), with the

exception of the hybrid individual (0.012), and most of the sampled individuals from Lebanon had 1st or 2nd degree kinship.
Although the small sample size of most populations requires caution in interpreting our results, they reflect the declining demographic trend in the species and highlight the need for careful interventions in the conservation and management of the isolated populations that currently constitute the species range. Random genetic drift and founder effect, associated with increasing inbreeding levels over generations, are well known problems in small and isolated populations, such as the case for the Nubian ibex. Although the genetic diversity in this species is higher than that of Alpine ibex (*Capra ibex*), we recommend that the management and conservation strategies for Nubian ibex strive to mitigate inbreeding and increase gene flow to slow down the genetic erosion and reduction of adaptive potential in the species. Actions should also be taken to prevent hybridization with domestic goat both in the wild and captivity.

N. 70

Snapshot Europe: A collaborative camera trap network for large-scale mammal surveys

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Understanding and addressing global socio-ecological challenges, such as the biodiversity and climate crises, requires ecological data collected at spatial and temporal scales that match the magnitude of these processes. Yet, when assessing the status and trends of wild animal populations, surveys are often fragmented and limited in their spatio-temporal extent due to resource constraints and logistical challenges. Moreover, data from different surveys are often difficult to integrate due to differences in sampling protocols and restricted data sharing. The Snapshot Global initiative was developed to overcome these barriers through coordinated, collaborative, large-scale camera-trap surveys and standardized protocols.
Here, we present Snapshot Europe, a pan-European component of Snapshot Global that conducts annual surveys of terrestrial mammals and birds using a harmonized camera-trap protocol. Data is collected between September and October of each year and then publicly shared through collaborative publications to which all data contributors are invited as co-authors. By combining standardized protocols with open data sharing, the initiative enables robust analyses of species distributions, community composition, and responses to environmental and anthropogenic drivers.
Launched in 2021, Snapshot Europe is approaching its sixth year of data collection and already comprises over 224,000 detections of 75 mammal species and more than 14,000 detections of 129 bird species, spanning 5000+ locations across 26 countries. Data were contributed by hundreds of expert camera trappers from over 100 universities, research institutes, and non-governmental organizations across Europe.
The dataset addresses the critical need for comprehensive data on wild animal populations across Europe and provides a valuable, open-access resource for ecological research. It also enables comparisons of trends across years and global comparisons through data collected by sister initiatives run in the USA, Japan, Chile, Brazil, and new countries that plan to join Snapshot Global in the near future. Designed to generate long-term time series, Snapshot Europe and Snapshot Global offer a valuable solution to the need for robust, large-scale, and long-term standardized surveys.

N. 71

Perceptions of human-wildlife coexistence in a changing alpine landscape

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Understanding the diversity of ways in which people view, value, and relate to the natural world is essential for promoting sustainable coexistence between humans and wildlife in shared landscapes. Whilst conceptual tools such as the Life Framework of Values help organise and account for different value typologies in environmental settings, they focus primarily on positive forms of human-nature relationships. This focus tends to overlook orientations of separation, indifference, or antagonism towards nature which are often common in situations of socio-environmental conflict, such as human-wildlife conflict. Our study provides the first qualitative empirical application of an expanded Life Framework of Values which incorporates the novel life frame *living apart from nature, consisting of the worldviews living against-, living separated from-, and living disconnected from-/living indifferently to- nature*.
In the context of the TransWILD project (Biodiversa+), we conducted 42 interviews with interest groups (livestock farmers, crop farmers, hunters, tourism operators, protected area managers, forest rangers, loggers, and environmental NGOs) in the Alpi Ledrensi and Judicaria Biosphere Reserve (Province of Trento, Northeast Italy), an area where large carnivores, ungulates, and birds of prey have made a substantial comeback in the last 50 years due to shifting habitat conditions, stricter conservation policies, and species reintroductions.
Participants expressed divergent, though often co-occurring, values and emotions towards wildlife, ranging from appreciation and cultural attachment to fear, and perceived loss of control over the landscape. Although participants' value orientations and worldviews do not appear to be internally consistent, these are more often embedded in shared narratives of landscape change associated with landscape stewardship and a growing sense of separation between urban and rural experiences of wildlife and the natural world in general.
We conclude that landscape narratives play a central role in shaping conflicts and expectations surrounding wildlife management and potential human-wildlife coexistence scenarios.
Further research should situate human-wildlife interactions within their historical, spatial, socio-economic, and cultural contexts. More importantly, further research should go beyond preventive and compensatory mitigation measures and address the plurality of values, worldviews, and identities associated with changing landscapes and underpinning human-wildlife conflicts.

N. 72

The importance of traditional chestnut orchards as roosting and foraging habitats for bats in South Tyrol (Northern Italy)

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Traditional chestnut orchards represent semi-natural agroforestry systems of high ecological and cultural value in South Tyrol (Northern Italy). They are characterised by extensive management practices, the presence of old, large-diameter trees, and a high availability of tree-related microhabitats (TreMs). This study assessed the availability and use of TreMs as bat roosting sites, with particular focus on rare and endangered forest-dwelling species, such as *Myotis bechsteinii* and *Barbastella barbastellus*, and evaluated bat activity within traditional chestnut orchards.
Ten chestnut orchards were selected across South Tyrol, each covering at least one hectare and characterised by 36-182 mature and old trees rich in TreMs and ongoing chestnut production. Surveys were conducted at five sites in summer 2024 and five in summer 2025. TreMs were surveyed following a standardised protocol, focusing exclusively on microhabitat types considered potentially suitable for bat roosting, including cavities, crevices, loose bark, rot holes, and deadwood features. All potential roost structures were inspected by a professional tree climber using direct visual inspection and endoscopic equipment. Bat activity was assessed using passive acoustic monitoring with Batlogger A+ devices, deployed for three consecutive nights per site. In 2024, acoustic surveys were conducted between July and August, whereas in 2025 recordings were made in June and September.
A total of 635 potentially suitable TreMs on 69 trees were examined across the ten study sites. However, inspections revealed no evidence of active bat roosts, maternity colonies, or long-term occupancy, such as accumulations of bat guano. Approximately 10% of the potentially suitable TreMs showed evidence of use by other cavity- and tree-dwelling vertebrates, including the edible dormouse (*Glis glis*), wood mice (*Apodemus* spp.), and cavity-nesting birds, particularly tits (family Paridae) and woodpeckers (family Picidae). Despite the absence of roosting evidence, acoustic monitoring recorded 3,538 bat passes over 300 recording nights, indicating bat activity within the study area. On average, seven bat species per site were detected (range: 3–10), with at least 17 species or species groups recorded overall. *B. barbastellus* was detected at 6 of the 10 sites, whereas *M. bechsteinii* could be identified at a single site only, based on the detection of 49 social call sequences. Bat passes and foraging activity showed seasonal variation, with higher activity in June and September (mean: 88–308 calls per night) compared to July and August (2–123 calls per night), indicating temporal shifts in habitat use.
Overall, our preliminary results suggest that traditional chestnut orchards are used by bats primarily as foraging habitats, including forest-dwelling species such as *B. barbastellus*. Seasonal variation in bat activity may be linked to the flowering phenology of chestnut trees. In contrast, chestnut orchards appear to be of limited importance as reproductive or roosting sites for bats. However, these findings remain preliminary and require further investigation regarding the importance of chestnut orchards for bats compared to surrounding forest habitats and to robustly assess seasonal patterns.

N. 73

Traces in the water: eDNA reveals the return of the European Otter *Lutra lutra* to Central Italy

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Genetic monitoring plays a fundamental role in the conservation and management of protected or expanding species. The analysis of species-specific DNA fragments in environmental samples (environmental DNA, eDNA), such as water, represents an effective and non-invasive tool for detecting elusive and semi-aquatic mammals. The Eurasian otter *Lutra lutra* experienced a marked decline across Europe during the 20th century and was declared extinct in the Lazio and Tuscany regions between the late 1980s and early 1990s. However, recent camera-trap monitoring conducted in southern Tuscany (Arezzo province), together with the recovery of a dead otter along the Magra River in northern Tuscany, highlighted the need to further investigate the current presence and distribution of the species at regional scales. In this study, eDNA-based monitoring for *L. lutra* was applied in Tuscany and northern Lazio across several river systems. Water samples were analysed using species-specific real-time quantitative polymerase chain reaction (qPCR) assays. Positive otter eDNA signals were recorded at multiple sites. The abiotic parameters positively associated with the occurrence of the species in some rivers were identified through multivariate analysis (e.g, water surface velocity). The eDNA-based approach, combined with environmental data, represents a valuable complement to traditional monitoring methods and a promising tool for improving knowledge of the current distribution of the Eurasian otter. Therefore, in order to obtain a more comprehensive and accurate assessment of the species' distribution in central Italy, additional data will be collected by expanding sampling to new river stretches.

N. 74

The Mediterranean Monk Seal in Italy: Six Years of Sightings Provide Information for a "Data Deficient" Species

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In Italy, the Mediterranean monk seal (*Monachus monachus*) is currently listed as "Data Deficient" (DD) by the IUCN, indicating that there is insufficient information to assess its conservation status and implement targeted protection measures. Despite this, in recent years, the number of sightings in Italian waters has been increasing, suggesting a regular presence of the species. This study contributes to addressing this gap by documenting opportunistic sightings of the species along Italian coastlines over the past six years (from January 2020 to December 2025) and assessing their relevance for revising the national classification. Sightings were collected by Gruppo Foca Monaca (GFM), an Italian organization active since 1976 that promotes species protection through citizen engagement and systematic data validation. Sightings were gathered via social media and interviews, then verified through a standardized procedure to ensure reliability. A total of 113 validated sightings out of 129 collected were recorded across 13 of Italy's 15 marine regions: Campania (25), Sicily (24), Apulia (23), Tuscany (9), Calabria (9), Basilicata (3), Friuli Venezia
Giulia (2), Sardinia (2), Abruzzo (1), Molise (1), Veneto (5), Emilia-Romagna (3) and Marche (6). Annual frequencies varied, with peaks in 2025 (n = 50) and 2022 (n = 22), followed by 2023 (12), 2024 (10), 2020 (10), and 2021 (9). Notably, two pups were documented, one in Apulia (2020) and one in Calabria (2023), and adult individuals were identified, including an adult male recorded in Campania (2025). Overall, the collected sightings data, whose recent rise may reflect increased citizen engagement, provide evidence of *Monachus monachus* presence in Italian waters, consistent with previously published environmental DNA (eDNA) results. The documentation of pups (despite not surviving), juveniles, and mature individuals also suggests possible reproductive activity. Taken together, these results highlight the need to consider and implement appropriate conservation and management measures, especially in coastal environments subject to high anthropogenic pressure (e.g., the adoption of codes of conduct and the protection of habitats suitable for the species), while also providing a baseline for reassessing the species' current national classification and guiding future conservation strategies.

N. 75

Demography and ecology of *Muscardinus avellanarius* in an alpine environment

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The hazel dormouse (*Muscardinus avellanarius*) has traditionally been considered a lowland species, although it has been occasionally observed in mountain habitats at elevations up to 2,000 m. Our research aims to enhance knowledge on the demography and ecology of the hazel dormouse in an alpine environment, providing deeper insight into its spatial and temporal distribution, population dynamics, and the influence of vegetation characteristics on its presence and abundance. The study is part of a long-term monitoring project started in 2019 in Valsavarenche and Val di Rhêmes, two valleys within the Gran Paradiso National Park, Western Italian Alps.

Six nest box grids – three per valley to ensure spatial replication – were established along an altitudinal gradient ranging from 1,200 m to 2,000 m a.s.l., with each grid comprising 22–40 nest boxes. Nest boxes were checked irregularly during the initial years, with inspections becoming more frequent from 2022 onward. A capture-mark-recapture (CMR) approach was applied: animals found in nest boxes were temporarely placed into plastic bags, weighed, sexed, and marked with a unique PIT tag. Population abundance was subsequently estimated using both POPAN models and Bayesian approaches. Relationships between dormouse occurrence and environmental variables were explored using exploratory regression analyses at the study-area level, and further evaluated through a Bayesian Dynamic Occupancy model.

The analysis revealed a non-homogeneous distribution of the hazel dormouse, with a clear preference for high-altitude areas around 1,900 m, where the majority of captures and all recorded reproductive events occurred. These findings contradict the traditional view of the hazel dormouse as a low-altitude specialist. Demographic analysis showed marked seasonal fluctuations, with abundance peaks between August and September. Density estimates based on the Bayesian models reached up 5 individuals/ha during late summer, representing the first density estimate for the species in an alpine environment. The analyses at the area level and the occupancy model highlighted the importance of arboreal and shrub cover, and particularly habitat structural complexity, as key determinant factors for the hazel dormouse presence.

The presence and relatively high abundance of hazel dormice at high elevations challenge conventional assumptions about suitable habitats for the species. Notably, the area with the highest estimated density is located at the upper edge of the forest vegetation and is characterised by sparse conifer trees, high shrub cover, and a mosaic of alpine meadows. This unexpected preference for areas close or above the timberline in the Alps may be explained by the abundance of fruit-producing plants. Indeed, the presence of shrub species such as *Rubus*, *Rhododendron* and *Vaccinium*, which provide important seasonal trophic resources, was positively associated with capture rates.

Overall, these results highlight the ability of the hazel dormouse to exploit alpine environments and suggest that vegetation diversity and structural heterogeneity, rather than continuous forest cover, represent key ecological factors for its persistence in the Alps. This novel insight into the occurrence and abundance of the hazel dormouse at high elevations highlights the need for further research to fully understand the species' ecology in these extreme alpine environments.

N. 76

Urbanization shapes fear responses to novelty and human cues in red foxes

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Urbanization profoundly reshapes wildlife behavior by altering the balance between risk and opportunity. Among mesocarnivores, red foxes (*Vulpes vulpes*) are one of the most successful species thriving in urban areas, yet how urbanization affects their fear responses to anthropogenic cues remains poorly understood.
We conducted behavioral tests at a total of 47 testing sites covering a range of urbanization levels, using camera traps to present free-ranging foxes with two types of stimuli: a Novel Object test (two different unfamiliar objects presented consecutively) and a Playback test (broadcasting human voices and control sounds).
An urbanization effect emerged in both tests. In the Playback test, the likelihood of showing a fear response to the human voices was significantly lower in more urbanized sites compared to the wilder ones. In the Novel Object test, only 5% of foxes showed a fear response to the first object, and this was not affected by urbanization. However, interestingly urban foxes tended to show more fearful reactions when facing the second novel object compared to wild foxes, which generalized more between the two stimuli, showing a similarly low likelihood of a fearful response to both stimuli. Findings are in line with our recent results on wild wolves and are consistent with the *Urban Sensitivity Hypothesis* suggesting that the effect of urbanization may be more nuanced than a simple blanket reduction in fearfulness.
These results highlight how red foxes are well adjusted to human-dominated environments, showing behavioral traits that facilitate their persistence and success across urban landscapes, they also invite researchers to design studies which investigate animal's responses in multiple contexts, and with repeated exposures.

N. 77

Environmental determinants of roe deer body mass in a Mediterranean context

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Body mass is a key ecological trait reflecting mammal phenotypic quality, closely linked to individual survival and reproductive potential, in turn potentially influencing population dynamics. Understanding the relative importance of its determinants, such as weather, habitat characteristics, and population density, is essential to predict individual and population responses to environmental variation. This is becoming increasingly crucial given ongoing changes in climatic patterns, as well as the recent increase in the density and distribution of ungulates. We focused on a widespread herbivore of temperate ecosystems, the roe deer *Capreolus capreolus*, to investigate how environmental factors shape body mass across sex and age classes in a Mediterranean context.
We analysed body mass data collected over 15 years during selective hunting in central Italy. For different sex and age classes, we tested the effects of environmental variables, i.e., average temperature, precipitation (for fawns only), habitat composition, habitat heterogeneity measured using a Shannon index, and population density. Weather variables referred to the previous spring–summer period, corresponding to birth and early growth stages, and habitat metrics were used to describe resource availability and landscape structure.
Temperature and precipitation showed weak effects on fawn body mass, suggesting that milder and wetter conditions during birth and weaning may slightly enhance early growth. Habitat heterogeneity had contrasting effects between sexes, positively influencing female body mass but negatively affecting males, particularly during warmer months. Moreover, fawns inhabiting broadleaved woodlands exhibited higher body mass than those in agricultural areas, likely because farmland is largely bare in autumn–winter and provides fewer trophic resources. Population density was not a significant determinant of body mass variation.
Overall, our results highlighted the predominant role of habitat features and, to a lesser extent, weather conditions in driving body mass differences in roe deer within Mediterranean ecosystems. These findings suggest that maintaining high habitat diversity is crucial for supporting individual body condition, especially in females, which is a key predictor of reproductive performance. Management strategies should incorporate seasonal and sex-specific ecological requirements, particularly in the face of ongoing climate and habitat changes that may markedly affect the phenotypic quality and population dynamics of this income breeder.

N. 78

Tool for the notification of unusual mortality and symptoms in bats. Project CABLES

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The protection of natural heritage is a common challenge for the European Union within the 2030 Biodiversity Strategy. In Italy, several bats are declining due to the destruction and fragmentation of their habitats, direct disturbance and pollution. New challenges include the effects of climate change, such as heat waves, droughts and rising average winter temperatures, and the spread of infectious diseases. In this sense, some viruses potentially pathogenic to bats fall into the families of greatest interest for the emergence of diseases in humans. Among these, European bats are associated with six viruses belonging to the *Lyssavirus* genus considered capable of causing rabies in humans and animals. While several studies report bats tolerance to infectious diseases, it is likely that mortality events are overlooked or underreported. In this context, integrating information and data from ecological monitoring and sanitary monitoring would be necessary, also responding to the One Health concept. In addition, the application of citizen science could provide higher sensitivity to the system, allowing for local detection of mortality events or unusual symptoms and behaviors. The project CABLES (INTERREG ITAT 27 011), co-funded by the European Union, wants to respond to this challenge and define protocols for monitoring the health bat populations. While the development of active and environmental surveillance will be developed and tested to investigate *Myotis myotis* and *Myotis blythii* in the INTERREG area, WP5 aims at providing tools to detect and investigate mortality events across species and locations, including an official reporting system and a standardized diagnostic protocol for laboratories. In this study, we describe the development of the reporting system to be integrated within the webpage of the National Reference Centre for Rabies of the Istituto Zooprofilattico Sperimentale delle Venezie (IZSVe). In order to optimize resources, we combined the development of this tool to concomitantly report mortality events, relevant symptoms and abnormal behaviour, which could help improving current surveillance for rabies. Indeed, the occurrence of abnormal behaviour classify the animal as suspect for the infection with Lyssavirus. We created a reporting tool using Limesurvey, an open source software dedicated to collect quantitative/qualitative data through structured questions. Throughout the reporting form, we used equally standardised questions and open-ended questions, based on the information that needed to be collected. We designed the online form to be filled out through a link from the IZSVe website. At the end of each compilation, the data will be automatically recorded by the online software and will send an alert via email to the experts involved in the project. The virtual reporting form was divided in three sections. The first session is general and aims at collecting: i. contact details of the submitter in case further investigation is needed and level of expertise in the field of bat ecology/biology and medicine; ii. date, location and species involved by the unusual event. The second session responds to the duplicity of the tool's objectives and presents a filter question, 'What did you encounter?', based on which respondents will be directed to either section A (abnormal behaviour) or B (mortality events). The final section A contains in-depth questions about behavioural changes in bats and injuries or symptoms prevalent in the population while the final section B contains questions about mortality. The tool include built in answers to the questionnaire, providing, based on the specific answers, general indications to the user for the following steps to be taken, if any. In conclusion, we believe the new tool for the notification of unusual events in bats will help to better evaluate the health of these animals and assess possible implications for human health. In particular, the open access of the system will guarantee the collection of data from both bat experts and common citizen, securing broad distribution of incoming data and targeted information of populations during ecological monitoring. The integration of the system within the institutional website of IZSVe will guarantee official evaluation of reports to assess the severity of the event and provide an appropriate response as quickly as possible.

N. 79

Preliminary evaluation of baits and lures for monitoring the community of mammals in Umbria with a special focus on the European polecat (*Mustela putorius*)

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Baits and lures are well known to be useful assets in camera trapping studies to significantly increase the probability of wildlife detection by stimulating their explorative behaviour, triggering a predictable response that is useful for the sake of the study. An attractant can be defined as any element, whether a substance, material, device or technique, used to attract a target species to stand in front of the camera trap. Effectiveness is generally species-specific, but some types of attractants such as sardines, are often chosen by researchers because they are appreciated by a wide range of species. This study aimed to test the effectiveness of three baits and a lure in an exploratory monitoring of the Mammal community in the Pietralunga area, with a particular focus on detecting the presence of the European polecat (*Mustela putorius*). This small mustelid, included in the Habitats Directive, was chosen since its status in Italy is still poorly known, due to its low population density and its elusive and markedly nocturnal habits. Therefore, this study aimed to test whether the use of attractants, could allow the detection of the species in a habitat potentially suitable for its presence. Two linetraps were identified, each consisting of six sites located in the proximity a stream. A camera trap was installed at each site, operating 24 hours a day, exclusively in video mode, with a recording duration of 20 seconds and an interval between each detection of less than 5 seconds. The camera traps were arranged at a height of approximately 30–50 cm above the ground and at a distance of around 500 m from each other, for an overall transept of approximately 3 linear km. An attractant was associated with each camera trap, a control site (i.e., a camera trap without attractant) was allocated in both linetraps. A broad spectrum of attractants was selected from scientific literature, such as: *Valeriana officinalis* hydroalcolic extract, peanut butter, blueberry jam and sardines. The monitoring started on November 18th, 2024, and ended on March 1st, 2025, for a total of 582 trap nights and 1,412 video captures, of which 930 were valid for the purposes of the study. Among the 13 species detected, the ones with the greatest relative abundance were the red fox (*Vulpes vulpes*, 25.8%), followed by the domestic cat (*Felis silvestris catus*, 20.5%) and the stone marten (*Martes foina*, 12.8%). The European polecat was successfully detected, with a total of 12 video captures (1.3%) clearly and unambiguously attributable to the species, including sequences showing predatory behavior. For both linetraps, the control site, lacking attractants, recorded a significantly lower number of videos compared to the baited stations. Sardines were the attractant that recorded the highest number of interactions events (117), followed by valerian extract (32), jam (19) and peanut butter (9). The stone marten was the species that interacted most frequently with the attractants (36), a behavior diametrically opposed to another mustelid, the European polecat, which confirmed its elusive nature, with a single interaction with sardines. Whilst fox interactions (47) were more numerous, compared to the stone marten, the number of videos from foxes was far greater (240) than the videos from stone martens (119). Other species interacted scantly with the attractants. Overall, baits and lures proved to be effective in enhancing the detection of the Mammal community in the study area. However, it remains unclear how the different species respond to the multiple types of baits that can be used with this monitoring system. For this reason, it would be appropriate to conduct further studies testing different attractors and involving a larger number of species. *Mustela putorius* turned out to be present, although with limited abundance, in the Pietralunga area. Considering the species' ethology and the timing of the survey, the monitoring yielded positive results confirming the presumed habitat suitability.

N. 80

Habitat use of European badger in a mountainous landscape

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The habitat use of European badgers *Meles meles* remains relatively understudied in mountainous environments, particularly in Alpine regions. In this study, we investigated the habitat use of European badgers in a study area within the Stelvio National Park (central Italian Alps) and assessed whether they exhibit different patterns compared to habitats commonly frequented by this species. We collected data from May to October between 2019 and 2023 using 45 camera traps randomly distributed over the study area, spanning elevations from 1400 to 2500 m a.s.l. We fitted a single- season, single-species occupancy model to calculate detection and occupancy probability as a function of site-specific environmental covariates. Our findings indicate that badgers primari ly used areas with a high percentage of forest cover at lower elevation, favouring these habitats over higher elevation areas. Although badgers were detected at remarkably high elevations (up to 2406 m), most detections occurred below or near the treeline. This preference reflects the importance of forests, which provide abundant food resources and suitable soils for sett construction. Additionally, badgers tended to avoid north-facing slopes, possibly due to less favourable conditions such as colder temperatures. Furthermore, they showed a slight tendency to use steeper slopes (15–20 degrees) likely due to better drainage and more opportunities for sett construction, and appeared to be unaffected by human activity. These findings provide new insights into the habitat use of badgers in mountainous regions, highlighting the species' plasticity and its ability to adapt to diverse landscapes and environmental conditions.

N. 81

Testing a new monitoring method for invasive alien species: utilising thermal camera-equipped drones for the study of the coypu (*Myocastor coypus*)

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The coypu (*Myocastor coypus*) is recognized as one of the most impactful Invasive Alien Species (IAS) in Europe, posing severe threats to both ecological stability and economic activities, as framed by Regulation (EU) 1143/2014. In the Basilicata region (Southern Italy), where an active Control Plan is currently in effect, traditional census methodologies often yield suboptimal demographic data due to low population densities, dense riparian vegetation, and logistical constraints in accessing remote riverine habitats. Consequently, there is an urgent need for advanced, non-invasive monitoring protocols to enhance management effectiveness. While Unmanned Aircraft Systems (UAS) are increasingly employed in wildlife research, their application for M. coypus detection remains largely unexplored. This study evaluates the efficacy of a UAS-based monitoring framework utilizing a DJI Mavic 3 Thermal equipped with high-resolution RGB and radiometric thermal sensors. This trial represents a methodological milestone, being the first systematic effort to census this species within the Basento, Cavone, and Agri river basins, areas of high conservation value integrated into the Natura 2000 network (IT9220085, IT9220095, IT9220080). Field surveys were conducted between April and May 2025, employing nine replicated transects across distinct time intervals. To ensure rigorous geospatial accuracy, flights were maintained at a constant altitude of 30 m Above Ground Level (AGL), supported by a Real-Time Kinematic (RTK) positioning system for high-precision spatial mapping. The post-processing workflow involved photogrammetric processing with a Structure From Motion software to generate high-resolution thermal and RGB orthomosaics. These outputs were integrated into a Geographic Information System (QGIS) environment for identification through expert photointerpretation. To ensure analytical robustness, a dual-check procedure was implemented by cross-referencing processed maps with original raw frames, thereby accounting for potential photogrammetric artifacts and ensuring reliable individual counts based on thermal signatures against the environmental background. Preliminary findings confirm the presence of the species within the Cavone river basin. However, environmental variables, particularly wind-induced surface turbulence and specular reflection on water, presented technical challenges for 3D photogrammetric reconstruction. Despite these constraints, the integration of thermal imagery significantly improved detection rates compared to traditional ground-based methods. This study establishes a new technical standard for the management of IAS in complex fluvial ecosystems. Future research phases will integrate this high-resolution spatial data into Distance Sampling protocols and Occupancy Models to transition from direct counts to rigorous population density estimations. By providing precise demographic insights, this approach aligns with regional and national strategic frameworks, ensuring that management interventions are evidence-based, spatially optimized, and ecologically sustainable.

N. 82

Population dynamics and spatial monitoring of wild boar (*Sus scrofa*) in contiguous Mediterranean ecosystems: a case study from the "Terra delle Gravine" Regional Natural Park and the "Bosco delle Pianelle" Regional Mananged Nature Reserve

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The demographic expansion of the wild boar (*Sus scrofa*) in Italy has transitioned from a chronic management challenge to a critical national sanitary emergency due to the emergence of African Swine Fever (ASF). This pathological threat necessitates a paradigm shift toward rigorous containment and systematic monitoring. In compliance with the „Apulia Regional Plan for Urgent Interventions (PRIU) for the management, control, and eradication of African Swine Fever in farmed and wild suids", a two-year monitoring programme (2024–2025) was conducted. The study area comprises the „Terra delle Gravine" Regional Natural Park (28,000 ha) and the „Bosco delle Pianelle" Regional Managed Nature Reserve (1,200 ha), which form an ecological continuum facilitating high population mobility across karst canyons and broad-leaved forests. Monitoring relied on systematic camera trapping at controlled feeding sites to maximize detection probability while minimizing anthropogenic disturbance. A total of 40 stations (30 in the Park; 10 in the Reserve) were monitored for a minimum of 30 consecutive days per session during spring and autumn. Population trends were assessed on a spatio-temporal scale to estimate the Minimum Number of Individuals (N_{min}), characterize social groups, and determine sex ratios, thereby providing a comprehensive demographic overview within the regional emergency framework. The study documented a widespread species distribution across both jurisdictions, although with distinct demographic patterns. Within the Terra delle Gravine Regional Park, occupancy rates fluctuated between 50% and 67%, with N_{min} detections shifting from 156 in Spring 2024 to 65 in Autumn 2025; however, stable Trap Rates confirm that these variations are likely linked to seasonal resource availability and the complex karst topography rather than a structural population decline. Conversely, the Bosco delle Pianelle Regional Reserve exhibited a nearly ubiquitous presence, reaching 100% occupancy in the final session. Despite its smaller territorial extent, the Reserve demonstrated intense biological activity with N_{min} values ranging between 43 and 78, stabilizing at 51 in late 2025. A significant finding, exclusive to the Reserve, is the progressive increase in hybrid phenotypes, whose N_{min} rose from 3 to 11 individuals during the study period. The integrated analysis confirms that the Gravine-Pianelle complex functions as a single functional unit with a stable population. This stability underscores the importance of a coordinated, cross-boundary monitoring approach within the regional ecological network. The documented rise in hybrid individuals within the Reserve represents a priority for future management and selective control actions. These results provide a vital empirical baseline for the implementation of the PRIU Puglia, suggesting that ASF management strategies must account for the ecological continuity and the specific demographic composition of these protected areas to ensure long-term ecosystem integrity and effective disease mitigation.

N. 83

Cold, heat and activity: how weasel responds to thermal conditions

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The weasel *Mustela nivalis*, the smallest extant carnivore, is a small-bodied predator in which thermoregulatory demands may influence activity patterns. Its small size, elongated morphology and high metabolic rate implies high energetic costs which can contribute to context-dependent behavioural adjustments. Quantifying the links between activity and thermal conditions provides a useful baseline for interpreting behavioural responses in changing climatic regimes. We investigated daily and seasonal activity of weasels using radio-tracking in the Regional Natural Reserve of Lungo and Ripasottile Lakes, in the province of Rieti, central Italy. Between February 2003 and June 2004, twelve individuals were radio-tracked, yielding 1,844 fixes collected under a 15-min sampling schedule.
Weasels showed a predominantly diurnal activity pattern, with significantly higher activity during daylight compared to night and twilight phases. Seasonal variation was pronounced, with lowest activity in spring and summer and highest in winter. Activity increased with rising ambient temperature in all seasons except winter. Within the observed temperature range, we did not detect evidence of reduced activity at either high (>25 °C) or low (<–10 °C) conditions. Our results suggest that, under humid conditions and in the absence of stable snow cover, limitations related to heat retention may be particularly relevant for resting behaviour. Increased winter activity may reflect a compensatory response to heat loss during rest. Overall, the local climatic context may influence behavioural responses to temperature, providing relevant evidence on the ecology of small mammals in changing climatic conditions.

N. 84

Wolves of Rome: occurrence, social structure and genetic identity

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In recent years, the Italian wolf (*Canis lupus italicus*) has steadily recolonized peri-urban areas in central Italy, confirming its ability to exploit human-dominated and highly fragmented landscapes. The metropolitan area of Rome represents a particularly complex setting, characterized by a mosaic of protected areas, agricultural lands, high density of infrastructures, and densely urbanized zones. We report on the occurrence, social structure and genetic characteristics of wolves in the peri-urban area of Rome, a replication site of the EU-funded LIFE Wild Wolf project, from October 2023 to December 2025. The study area includes the Veio and Bracciano–Martignano Regional Parks (317 km²), the Litorale Romano State Nature Reserve (72 km²), and four reserves managed by RomaNatura (R.N.R. Decima Malafede, R.N.R. Insugherata, R.N.R. Tenuta dei Massimi and R.N.R. Marcigliana; cumulatively 124 km²). We used camera trapping and non-invasive genetic sampling (NGS) to obtain complementary information on wolf occurrence, distribution, packs' composition, and genetic identity. Genetic analyses were performed by ISPRA using 12 autosomal and 4-Y linked microsatellites to obtain individual multilocus genotypes and assess their taxonomic identity (i.e., wolf, dog, recent wolf-dog hybrid or wolf with dog introgression) through Bayesian assignment procedures. Pack assignment of identified genotypes was restricted to individuals represented by at least two samples supported by information from camera trapping. Camera trapping and NGS surveys were also locally supported by Global Positioning System localizations obtained from 7 collared individuals belonging to 7 distinct packs.
We collected 446 NGS (mostly scats), 352 of which have been genetically analysed. Including additional 13 invasive samples (from live-trapped wolves and individuals found dead), we identified a total of 63 multilocus individual genotypes, captured from 1 to 10 times during the study period. Of these, 49.2% were assigned to wolves, 30.2% to recent hybrids (i.e., up to the second generation of backcross to wolves), and 20.6% introgressed individuals derived from older backcross generations.
We estimated the residency of a minimum of 12 wolf packs for which we determined composition and seasonal variation in size. Accordingly, the minimum population size in the study area was estimated at 58 wolves in autumn 2025, excluding floaters, with average pack size

ranging from 6.2 (±4.1) in 2024 to 7 (±4.1) in 2025. Reproduction was documented for 10 packs during the 2025 breeding season, with an average litter size of 5.2 ± 2.6 cubs, with pups first detected in June-September.
Our findings reveal the stable presence of wolves in the immediate outskirts of metropolitan Rome and their reproductive success, underlying the extreme ecological plasticity of the species to adapt to fragmented and altered urban contexts. Although we did not witness aggressive behaviour towards humans or the occurrence of bold behaviour among the packs we studied, the close proximity of wolves and humans in these and similar settings calls for coordinated and evidence-based management strategies to prevent potentially critical situations.
Moreover, the high prevalence of domestic introgression suggests ongoing wolf–dog hybridization, with critical implications for the genetic integrity and conservation status of the local wild population.

N. 85

Proforestation and biodiversity: effects of forest management abandonment on the bat community

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Proforestation is increasingly recognised as an effective strategy for biodiversity conservation. The cessation of forest management promotes the development of structural complexity, including the accumulation of deadwood and the formation of microhabitats, key resources for many bat species. These features can enhance both roost availability and foraging opportunities, potentially shaping bat community composition.
In this study, we investigated the effects of time since management abandonment (TSA) and forest structure on bat communities. We selected three study sites representing different forest types: a thermophilous deciduous forest, an alpine coniferous forest, and a mountainous beech forest. At each site, three forest stands characterised by different stages of abandonment were identified: actively or recently managed, abandoned for over 30 years, and abandoned for over 60 years. Forest structure was also characterised in each stand through structural complexity indices calculated from LiDAR data, to support interpretation of bat community patterns. Bat data were collected using AudioMoth recorders, which were set with a sampling rate of 250 kHz to record 30 seconds every 10 minutes, from one hour before sunset to one hour after sunrise, over a sampling period of approximately two months (from early August to late September). Audio recordings were analysed using BatDetect2 for automated detection and classification of bat echolocation calls. Only detections with a confidence score > 0.5 were retained, and a single detection per audio file was counted to minimise double counting.
Bat activity at the community level was consistently higher in managed stands across all three study sites, indicating a negative effect of TSA. Similarly, stands with higher structural complexity resulted negatively associated with overall bat activity. When the community was partitioned into foraging guilds, the strongest responses to TSA were observed for open and edge space foragers, which showed higher activity in managed stands. In contrast, no significant effects of abandonment were detected for narrow space foragers, whereas their activity was positively associated with structural complexity.
Our findings suggest that forest management abandonment may lead to contrasting responses within bat communities. Managed stands appeared to sustain higher levels of bat activity, particularly benefiting open and edge space foragers, whereas structurally complex forests promoted conditions favourable to forest specialist species. However, acoustic monitoring primarily reflects foraging activity and provides limited information on roost selection. Future research integrating data on roost availability and use would help clarify the complementary role of managed and long-abandoned forests in bat conservation.

N. 86

Interaction between Red Wood Ants and Bats: a preliminary assessment in the Foreste Casentinesi National Park

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Red wood ants (RWAs) are ecologically dominant insects typical of cool and temperate forests of the Northern Hemisphere. They strongly influence habitat structure and ecosystem dynamics and are easily detectable due to their large nest mounds, built from a wide range of soil particles, fir needles, small twigs, and resin. During the second half of the 20th century, several RWA species were widely used as biological control agents because of their high predatory activity on forest arthropods. In Italy, more than 6,000 nests collected in the Alps were transplanted to different areas of the peninsula, mainly in the Apennines, where RWAs were previously absent, in order to limit herbivorous insect pests in fir, pine, and beech forests. Some of these transplanted populations are still persisting today.
RWAs and bats often coexist in forest ecosystems, creating the potential for indirect ecological interactions. By strongly affecting local arthropod communities, RWA presence may alter prey availability and spatial distribution for insectivorous bats, potentially generating small-scale heterogeneity in foraging conditions.
In this study, we investigated whether the presence of transplanted populations of *Formica paralugubris* influences bat activity and species richness in the Foreste Casentinesi, Monte Falterona and Campigna National Park (Italy). We selected two forest reserves hosting this ant species (Campigna and La Lama) and monitored bat activity from May to August 2025 using 14 passive ultrasonic recorders deployed at paired sampling points (7 located in areas with ant nests and 7 in control areas without ants). Bat echolocation calls were identified using Kaleidoscope Pro with a customized species list including all bat species known from peninsular Italy.
Contrary to our initial expectations, bat activity and species richness were higher in areas occupied by RWAs. Bat assemblages in ant-present sites were dominated by *Pipistrellus pipistrellus*, *Pipistrellus kuhlii*, *Eptesicus serotinus*, and a group of Myotis species. *P. pipistrellus* was the most active species across all sites, but the total number of bat passes recorded in areas with ant mounds was several-fold higher than in control areas.
RWA nests are known to provide shelter, food resources, and favourable microclimatic conditions for a wide range of myrmecophilous arthropods, including larval stages of several flying insects. This increased local availability of potential prey may enhance bat foraging activity around ant nests. Although direct interactions between RWAs and bats are unlikely, our results suggest that transplanted RWA populations may indirectly promote bat activity through bottom-up effects on arthropod communities, highlighting the complexity of trophic relationships in forest ecosystems. Further studies are needed to test the underlying mechanisms driving this association.

N. 87

Interaction between Red Wood Ant and Forest Mammals

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Ants are a group of keystone species widespread in temperate and boreal forests of the Northern Hemisphere. Due to their large and long-lasting mounds, built by collecting plant materials and soil debris, they have a significant impact on the functioning of forest ecosystems and across several trophic levels. Their colonies are made up by millions of workers, and their nest mounds host a rich invertebrate fauna, but they may also attract several vertebrates. Ant-vertebrates interactions are, however, still poorly known. Despite the key role and abundance in most of their distribution range, their conservation status (Near Threatened in the IUCN Red List) is raising increasing concerns as there is evidence of local decline and extinction. This study aimed to assess the interaction between ants and their nest mounds with mammal's species in different Alpine and Apennine Forests.
We recorded nearly 80 nests (of *Formica paralugubris*, *F. pratensis*, *F. aquilonia* and *F. rufa*) belonging to 9 different populations for one year, using camera traps installed in front of the nests.
Nearly 30.000 camera trap days were screened to document the different behavioural interactions recorded in 20 sec videos. After a pre-screening made with the DeepFaune software to remove blank videos we manually checked and documented several behaviours, such as anting, predation, curiosity, and burrowing, displayed by different mammal species such as wild boar, roe deer, foxes and different mustelids at different times of day and year. Our results show an important role of RWA towards mammal species, highlighting peculiar behaviours of several mammals on the ant nest not reported yet and pointing out their importance in preserving forest wildlife.
We suggest that emphasizing the important services ant provide to many protected mammals species may help to further promote RWA conservation and protection at both local and national levels.

N. 88

Effects of Extremely Low Frequency Electromagnetic Fields (ELF-EMF) on Wildlife: Sensitivity, Mechanisms, and Ecological Implications

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Extremely low frequency electromagnetic fields (ELF-EMF; ≈1–300 Hz) originating from electrical transmission systems, telecommunication infrastructure, satellites, and a wide range of anthropogenic devices, represent a pervasive environmental factor capable of interacting with sensory, neuroendocrine and behavioural processes in mammals. Behavioural evidence demonstrates magnetoreception in both subterranean and surface-dwelling rodents, implicating ocular and radical-pair–based mechanisms sensitive to weak oscillating fields. Additionally, chronic low-intensity exposures have been associated with modulation of melatonin rhythms. While such effects do not consistently translate into severe clinical outcomes, they reveal species-specific susceptibilities of relevance for mammalian ecology and conservation.
We conducted a targeted synthesis of peer-reviewed literature on mammals, integrating laboratory and field studies on rodents, bats, and domestic livestock, as well as recent reviews, meta-analyses, and reference exposure standards. Reviewed data focused on behavioural (orientation, nesting, foraging), neuroendocrine (melatonin), and production-related responses, with particular attention to exposure parameters such as intensity, waveform characteristics, and chronicity. In rodents, the wood mouse (*Apodemus sylvaticus*) has demonstrated the ability to orient nest-building activity using geomagnetic cues, with disruptions occurring when a radiofrequency magnetic field (100 nT, 0.9–5 MHz sweep) was superimposed onto the ambient field. This suggests that radical-pair–based magnetoreception, widely documented in other vertebrates, may also be functionally relevant in certain mammalian taxa. Additionally, the presence of magnetite has been documented in tissues of dolphins, tuna, salmon, and mice, underscoring the diversity of mammalian magneto sensory pathways. Studies on Ansell's mole-rat reveal that enucleation abolishes magnetic orientation, suggesting an ocularly mediated receptor system. In livestock, research on cattle has shown measurable biological responses when exposed to a 10 kV/m vertical electric field combined with a 30 µT horizontal magnetic field at 60 Hz, including alterations in oestrous cycle length and impacts on milk production. Studies on stray current further indicate that quadrupedal species and continuous contact with the ground may increase effective exposure compared to bipedal ones. Field studies in bats consistently show aversive responses near high-intensity radar installations, including reduced foraging activity independently of insect availability. Collectively, the available evidence indicates that ELF-EMF can influence mammalian physiology, behaviour, and sensory processing, although the magnitude and direction of these effects vary by species, exposure characteristics, and life stage. Quadrupedal mammals with high ground conductivity, species relying on magnetoreception, and those inhabiting areas near high-intensity EMF sources appear particularly vulnerable. Findings on neoplastic outcomes remain inconclusive, with a targeted signal for leukaemia in mice. Species-specific exposure monitoring (including magnetic flux density and contact currents) together with longitudinal studies reflecting realistic grid conditions and harmonics, are recommended to assess demographic relevance and guide mitigation in mammal-sensitive habitats. These findings highlight the need for additional taxa specific research to clarify exposure thresholds, cumulative effects, and potential conservation implications for wild and domestic mammal populations.

N. 89

Assessing the effects of Procyon lotor on *Austropotamobius pallipes* complex in Central Italy

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Freshwater ecosystem conservation is a global priority due to the rapid decline in biodiversity caused, among other factors, by the spread of invasive alien species (IAS). This study investigates the effect of the Northern raccoon (*Procyon lotor*), an omnivorous mammal from North and Central America, and the native white-clawed crayfish (*Austropotamobius pallipes* complex) within the Foreste Casentinesi, Monte Falterona, and Campigna National Park (FCNP) in Central Italy. By comparing historical monitoring data (2012-2016) with recent surveys (2021–2024), we analyzed variations in crayfish population abundance in relation to the documented presence of this alien predator. Sampling sites were classified based on spatial and temporal coexistence criteria to assess potential correlations.
Results highlight differences in crayfish Catch Per Unit Effort (CPUE)between areas colonized by raccoons and those not.
These findings suggest that the predatory pressure exerted by this invasive species may represent a significant additional stressor for *A. pallipes* populations, which are already threatened by multiple human-driven factors. Furthermore, the study discusses the potential role of the raccoon as an indirect vector for crayfish pathogens. These results underscore the importance of further investigating the ecological impact of IAS to refine management and protection strategies for native fauna within the park.

N. 90

Disentangling natural variability from observational error in biometric monitoring of hunted roe deer

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Despite the acknowledged importance of biometric monitoring in the study and management of Ungulates and the huge amount of potentially useful data provided by hunting activities, the accuracy of these measurements is often unknown. Moreover, addressing the size of the observational error of this kind of data could improve our ability to detect patterns (i.e. the statistical power of the models) of morphological changes in hunted populations.
To evaluate this kind of error we let 20 qualified biometric measurers to take 4 body parameters (head-trunk length: HTL, height at withers: HW, chest circumference: CC, length of hock: HL) measured to the nearest 0.1 cm and 2 cranial parameters (length of the teeth row: TRL, mandible length: ML) measured to the nearest 0.05 cm from the same roe deer, in the same day and room, following the same protocol (i.e. using the same reference points) and with the same tools (measuring tape for body parameters and caliper for cranial parameters). Data from each measurer were collected and for each body and cranial parameter indexes of data dispersion around the mean and the Coefficient of Variation (CV) were computed. The statistical comparison of the CV (by mean of the cvequality R package) of the different parameters pointed out that of the ML as the most accurate estimation: $CV_{ML} = 0.008$ while the others were on average 0.030 (min $CV_{CC} = 0.021$ max $CV_{TRL} = 0.043$). The Mandible length could then be identified as the most suitable biometric index, but unfortunately it is often the less measured (i.e. the smallest sample), because of the need to accurately clean the bone As an example in the data set from the same hunting province of the study the hunting bags recorded 5510 measures of HTL, 4527 measures of CC, 5697 measures of HW, 5863 measures of HL, but only 1816 measures of ML. The final choice, when needed, of the best index should be made evaluating both accuracy of the predictor and sample size.

N. 91

Non-Invasive Monitoring of Hazel Dormouse (*Muscardinus avellanarius*): First Insights on Genetic Data Quality From the First Pilot Study

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Genetic non-invasive sampling (gNIS) methods, which enable DNA extraction from naturally shed materials, offer a powerful, lowimpact tool for studying elusive species, minimising disturbance and ethical concerns. However, such approaches require careful assessment of sample quality and data accuracy to ensure reliable genetic results. The hazel dormouse (*Muscardinus avellanarius*) is an arboreal rodent that plays a crucial role in ecosystems. Despite conservation concerns arising from its low population densities, which are closely linked to habitat quality, it remains poorly understood due to monitoring challenges. This pilot study, conducted in the high Agri Valley (Basilicata, Italy), evaluates a non-invasive genetic sampling protocol for the hazel dormouse using hair-tubes. We investigated genotyping efficiency, the reliability and informativeness of selected microsatellite markers and the impact of hair sample quantity and trap placement duration on genotyping success and error rates.
Custom-designed hair tubes were developed to non-invasively collect dorsal hairs of *Muscardinus avellanarius*, using adhesive strips optimised for small arboreal rodents. Hair tubes were baited and deployed in a structured 3×3 grid design across 14 deciduous woodland sites and checked after two collection intervals, following an initial average exposure of 70.8 ± 0.9 days and a subsequent shorter average exposure of 41.2 ± 0.3 days, to assess a possible correlation between DNA degradation and hair exposure in the trap. Collected hair samples were identified morphologically as hazel dormouse hairs, preserved in ethanol, and stored under controlled conditions prior to laboratory analyses. DNA was extracted from hair bulbs and genotyped using a multi-tube PCR approach and a panel of 8 microsatellite loci to evaluate genotyping success, marker informativeness, and error rates in relation to hair quantity and exposure time.
Hair samples were obtained from 32 traps, yielding reliable multilocus genotypes for 14 distinct individuals. The microsatellite panel exhibited high allelic diversity and low probability of identity values, supporting its suitability for individual identification. Genotyping success was significantly influenced by both the number of collected hairs and the duration of trap deployment, with shorter exposure times and larger hair quantities increasing the probability of obtaining reliable multilocus genotypes. Allelic dropout represented the main source of genotyping error, whereas false alleles occurred at consistently low frequencies. This pilot study demonstrates that gNIS using hair-collection tubes can provide reliable individual identification for *Muscardinus avellanarius*, while revealing significant methodological challenges associated with DNA degradation. Genotyping success was strongly affected by both hair quantity and field exposure time, emphasising the need to minimise inspection intervals and optimise trap design to preserve DNA integrity. The incidence of allelic dropout suggests that further improvements could be achieved by refining the screening strategy and optimising the marker panel. This approach offers a tool for long-term monitoring of micro-mammals, supporting integrated assessments of population status and habitat quality in protected and human-influenced landscapes.

N. 92

No Country for Wolves: poaching events detected through GPS telemetry

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Understanding mortality causes is essential for predicting population dynamics of species of conservation concern. Poaching represents a significant threat to large carnivores, yet it is difficult to quantify due to detection bias associated with illegal killing. In the grey wolf (Canis lupus), population-level mortality assessments often rely on opportunistically recovered carcasses; however, this approach is affected by detection bias, as carcass recovery probability varies according to the cause of death. Satellite GPS telemetry provides a valuable tool to reduce such bias. Between 2005 and 2025, 88 wolves were equipped with GPS collars: 53 by the Monte Adone Wildlife Rescue and Research Centre and 35 by the Appennino tosco-emiliano national Park. Most individuals (85%) originated from the Emilia-Romagna and Marche regions; 72 were rehabilitated and released, while 16 were captured for research purposes. During the telemetry monitoring period, 20 wolves (24%) experienced at least one poaching event. Overall, 34 individuals (38%) died during monitoring, and poaching accounted for 16 deaths (47%). Poaching prevalence is likely underestimated, as contact was lost for 33 wolves (38%) due to collar malfunction unrelated to battery depletion. In many cases, cryptic poaching represents the most plausible explanation, as these individuals were never subsequently detected despite targeted searches (e.g. via VHF monitoring or camera traps). When extrapolating these results to the broader population, it should be considered that the telemetry monitoring window represents only a small fraction of a wolf's expected lifespan and that GPS-collared wolves may have a lower probability of being illegally killed than unmarked individuals—particularly in cases involving firearms—due to a potential deterrent effect. Conversely, rehabilitated wolves released back into the wild may be more vulnerable to anthropogenic threats, especially when released in suboptimal physical condition. These results suggest that poaching is a major and likely underestimated driver of wolf mortality in Italy.

N. 93

Effects of habitat fragmentation *per se* on two forest-dwelling small mammals in fragmented agricultural landscape

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Habitat fragmentation is a landscape-scale process widely recognized as one of the main drivers of global biodiversity decline. It encompasses multiple, interconnected processes, including fragmentation per se, habitat loss, habitat degradation, and the disruption of ecological connectivity among remnant habitat fragments. Among these processes, fragmentation per se plays a key role in shaping movement, dispersal, gene flow, and population persistence, particularly for forest-dwelling small mammals. Because species responses to fragmentation depend on level of habitat specialization and dispersal ability, we compared two forest-dwelling small mammal rodents, differing in these traits. Specifically, we focused on the hazel dormouse (*Muscardinus avellanarius*), a forest specialist with limited dispersal ability, particularly sensitive to forest fragmentation, and the yellow-necked mouse (*Apodemus flavicollis*), a more generalist forest-dwelling species with higher tolerance of the agricultural matrix, allowing it to cross open areas and maintain relatively high functional connectivity among fragments. By jointly studying these species, we assessed species-specific responses to fragmentation *per se*. Specifically, we evaluated the effects of fragment size and isolation on population relative abundance and sex ratio. Additional analyses also assessed the relative influence of both matrix characteristics and fragment habitat quality.
The study was conducted in a highly fragmented agricultural landscape surrounding the Appennino Lucano - Val d'Agri - Lagonegrese National Park (Basilicata, southern Italy), where forest cover was approximately 25%, a threshold at which fragmentation effects are expected to become detectable while management actions may still be effective. We selected 11 and 10 deciduous oak woodland fragments, dominated by *Quercus cerris* and *Q. pubescens*, for the hazel dormouse and the yellow-necked mouse, respectively, along gradients of fragment size and isolation. Sampling was conducted from May to October 2025 for the hazel dormouse (monthly surveys) and from May to November 2025 for the yellow-necked mouse, with each fragment sampled twice (spring/summer and autumn), using three consecutive trapping nights per trapping session. Demographic data were collected using capture–mark–recapture method, with nest-tube grids for the hazel dormouse and Sherman trap grids for the yellow-necked mouse. Individuals were marked and sex, age, reproductive status, and body mass were recorded. To evaluate the effect of fragmentation *per se* and explore the potential influence of landscape matrix composition and fragment habitat quality on the population relative abundance and sex ratio of the two species, we used three separate sets of models, each focusing on a different group of predictors. Fragmentation *per se* was evaluated at the patch scale through fragment size

and isolation. The relative influence of landscape matrix composition was quantified at the landscape scale within species-specific buffers around each fragment, while habitat quality was measured at the fragment scale through surveys of understory structure and resource availability. Relative abundance of both species was weakly related to fragment size but showed a consistent and significant decline with increasing fragment isolation, indicating that isolation represents the primary constraint on population relative abundance for both species. In contrast, matrix composition did not show detectable effects on either relative abundance or sex ratio for either species. Microhabitat characteristics did not influence relative abundance but were associated with sex ratio variation: for the yellow-necked mouse, male-biased captures increased with greater availability of trophic resources, whereas for hazel dormouse with greater vertical development of the understory.
These results highlight the need for targeted management actions to enhance ecological connectivity in the study area and in similar fragmented agricultural landscapes along protected-area borders, given that fragment isolation affected both species, including the more mobile yellow-necked mouse. In these contexts, coordinated actions can mitigate fragmentation effects and strengthen functional links with core protected habitats.

N. 94

Monitoring Wild Boar Behaviour in Relation to Fencing along the Tuscan Section of the A15 'Cisa' Motorway

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African Swine Fever (ASF) represents a serious threat to the European pig sector, with wild boar playing a key role in virus transmission. In Italy, the installation of artificial barriers along linear infrastructures is one of the main strategies to limit wild boar movements and contain disease spread. In this context, the present study aimed to assess the effectiveness of fences installed along the Tuscan stretch of the A15 "Cisa" motorway, analysing wild boar behaviour and movements in relation to fenced sections, gaps, and areas entirely without barriers.
Monitoring was conducted between June and November 2025 using 84 camera traps along the motorway. Devices were strategically placed in correspondence with gaps, fenced sections, and unfenced areas. Collected images were analysed through an automated workflow based on the R– YOLOv8 model, considering only events with a confidence level above 90%. Quantitative analyses focused on wild boar, roe deer, and wolves, including calculation of trapping rate, mean number of individuals per event, and spatial patterns using Kernel Density Estimation (KDE). Comparisons among area types were performed using t-tests and ANOVA, with a specific focus on nighttime activity.
During the study period, over 560,000 images were analysed, yielding 3,501 records of wolves, 14,987 of roe deer, and 25,563 of wild boars. Wild boar trapping rate was significantly higher in fenced areas compared to gaps (t-test, $p < 0.05$) and unfenced areas (t-test, $p < 0.05$), while no significant differences were found between gaps and unfenced areas ($p > 0.05$). Similar patterns were observed for roe deer, whereas wolves showed no significant differences across area types ($p > 0.05$). The mean number of individuals per event did not differ over 24 hours (ANOVA, $p > 0.05$); however, during nighttime, a significant increase was observed in unfenced areas (ANOVA, $p < 0.05$). KDE analysis identified three main activity hotspots along the motorway, highlighting priority sections with higher crossing risk.
Results indicate that fencing influences wild boar spatial behaviour, producing a concentration effect likely associated with exploratory movements and the search for crossing points. Gap permeability was comparable to unfenced areas, suggesting that no funneling effect occurs at gaps. Qualitative evidence also confirmed attempts to breach barriers and highlighted management challenges related to fence maintenance and gate operation. Overall, fencing along the A15 motorway represents a potentially effective tool to reduce landscape permeability to wild boar movements, but its effectiveness critically depends on fence continuity, proper maintenance, and appropriate management of gaps and gates.

N. 95

The price of freedom: temporal rather than spatial partitioning promotes coexistence between the Sardinian wildcat and domestic carnivores

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Feral dogs and cats are one of the most iconic representations of human negative impact on biodiversity, especially in island ecosystems. Understanding how these sympatric species coexist with wildlife is a central issue in community ecology.
The first camera-trap-based survey focused on the Sardinian wildcat (*Felis silvestris lybica*) started in March 2024 with the aim of increasing knowledge of its distribution, using remote sensing and non-invasive genetic sampling to understand the level of hybridisation with domestic cats. The project was indeed carried out integrating non-invasive monitoring techniques for the conservation and management of threatened and invasive species. With this study, we specifically aim at understanding the interactions between the Sardinian wildcat and domestic/feral dogs and cats, which have the greatest impact on wildcat conservation: hybridisation with domestic cats, predator-prey interactions with feral dogs, and competition with both. These interactions are particularly pronounced in human-dominated landscapes.
We analyse the spatial and temporal niche overlap among wild cats , feral dogs , domestic cats, and humans. We used a multi-year camera-trap monitoring (2024–2026; > 6,000 trap-nights; 53 stations 1–2 km apart), to create the first distribution map of Sardinian wildcat and increase the amount of information on the species' behaviour. Interactions among wildcats, dogs, and domestic cats were assessed by calculating spatial and temporal overlaps using kernel density estimation and Pianka's index. We have calculated the activity distributions of the different species and overlapped them to evaluate the degree of temporal interaction.
During the survey, wildcats showed nocturnal behaviour in most of the study areas, although daylight detection was more common during the reproductive season. Spatial overlap between feral dogs and wildcats was moderately high, with a Pianka index of 0.75, indicating use of the same areas, lower than the one with domestic cats (0.29). Conversely, temporal overlap between wildcat and the domestic species varied widely, being moderate with dogs (Δ=0.43) and humans ((Δ=0.30), but high with the domestic cat (Δ=0.71). It's crucial to note that most of the dogs we detected were stray/feral, not free-ranging owned dogs, and that at least three confirmed packs were found. The distribution data show how the Sardinian wildcat appeared more common than expected, preferring rocky outcrops and sites with high forest cover. Often, species segregated at least at one niche dimension (space, time, or trophic resources) to reduce competition.
The use of the same sites could be dependent on different factors, as tolerance of human disturbance by domestic carnivores or the presence of small prey like hare (*Lepus capensis mediterraneus*), wild rabbit (*Oryctolagus cuniculus*) or barbary partridge (*Alectoris barbara*). Moreover, mesocarnivores may respond differently to human disturbance, trophic opportunities, and intraguild interactions. Wildcats seam to avoid completely humans and dogs.
These results underscore the importance of expanding knowledge of spatial and temporal behavioural data to understand coexistence mechanisms and improve the management and conservation strategies to reduce the impact of domestic carnivores.

N. 96

Eradication project of invasive coypus from a protected wetland in central Italy

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The coypu (*Myocastor coypus*) is an invasive semi-aquatic rodent whose presence poses a significant threat to wetland ecosystems, biodiversity, agriculture, and infrastructure. This study aimed to assess the presence, distribution, and activity patterns of coypu within the Regional Park of Colfiorito (Perugia, Italy), to support management and eradication actions. In the first phase of the project, monitoring was carried out between January and June 2025 using an integrated approach combining camera trapping with wooden platforms baited with attractants (carrots) to detect indirect signs of presence. Five monitoring sites were established along the margins of the Colfiorito wetland, covering both aquatic and terrestrial habitats. A total of 3,643 videos were analyzed, corresponding to 829 independent detection events, 138 of which involved coypus. The species was recorded at all monitored sites, indicating a widespread presence across the study area, with variation in detection frequency among sites but no significant seasonal differences between winter and spring. Activity patterns showed that coypu were active throughout the day, with a marked peak after sunset. Although footprints were not detected on the platforms, camera trap data confirmed their use as feeding sites, highlighting their suitability for future trapping efforts. The estimated population size ranged between 20 and 40 individuals, with evidence of reproduction.
In the second part of the project, 10 cage-traps were placed around the wetland and kept active between 29/09/2025 and 28/11/2025, for 24 hours a day. Traps were controlled twice a day. 32 individual coypus were captured in 2 months. Captured individuals were humanely euthanized using compressed-air devices of calibres. Carcasses were subsequently transferred to an authorized specialized company for proper disposal. An additional capture session is scheduled for the spring of 2026.
Overall, the results showed the effectiveness of indirect monitoring methods for detecting low-density invasive populations and provide a solid baseline for planning targeted control or eradication measures in accordance with the Italian National Coypu Management Plan.

N. 97

ForestConnect: From Fragmentation to Connectivity - Scalable Solutions for Large Carnivore Conservation in Europe

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Habitat fragmentation and climate change are increasingly influencing the movement patterns and habitat use of large carnivores across Europe. The ForestConnect initiative, implemented within the Interreg Danube Region Programme, promotes practical and transferable approaches to maintain and restore ecological connectivity, improve coordinated monitoring, and support coexistence between humans and wildlife in and around protected areas.
To address it, a Strategic Action Plan was developed through a collaborative and iterative process. From the outset, a Strategic Expert Group was established to jointly steer the process. This group worked closely together throughout the project and collectively agreed on all major decisions, approaches, and strategic directions, ensuring a shared understanding and consistent development of the Action Plan. To define the overall direction of the Strategic Action Plan, a stakeholder workshop was held in February, bringing together key actors relevant to the project. The workshop served as an important moment for exchange and discussion, allowing participants to align expectations and identify priorities. Following this, four thematic working groups were set up to focus on specific thematic areas. Within these groups, participants worked closely together to translate the agreed strategic priorities into concrete actions. Each group developed draft actions for its respective topic, drawing on their expertise and practical experience. Throughout the process, several rounds of feedback were carried out with project partners and external experts. The continuous exchange and constructive input from both internal and external contributors played a key role in strengthening the final Strategic Action Plan.
It outlines actions aimed at ensuring safe wildlife movement across connected habitats, maintaining ecological connectivity, preventing and reducing wildlife mortality on roads, as well as establishing wildlife monitoring in ecological corridors. The booklet is structured into several implementation phases, each with a defined timeline, covering actions related to identification, design and implementation, monitoring, and community engagement. Examples of proposed actions include the adaptation of linear infrastructure through wildlife crossings and guiding structures, as well as targeted mitigation measures at conflict hotspots to reduce wildlife–vehicle collisions. It places emphasis on continuous and harmonized monitoring as the foundation for adaptive management and spatial planning. A digital, geo-referenced reporting and early-warning system connecting local verification bodies with mobile applications, cloud-based databases, and interactive dashboards. Also, the participatory communication strategies grounded in scientific evidence foster trust, address misinformation, and increase public acceptance of conservation measures. This project aims to address unsustainable management practices, infrastructure development, and climate change challenges. Considering their impacts on large carnivores, which adjust their movement patterns and habitat use in response to these pressures, the project proposes an integrated methodological and operational approach working with several stakeholder levels. Together, these measures form an integrated and scalable framework that strengthens ecological connectivity, supports human–wildlife coexistence, and enhances the adaptive capacity of both ecosystems and communities under ongoing climate change.

N. 98

Integrated monitoring of the Italian hare and the Italian roe deer in the Gallipoli Cognato Piccole Dolomiti Lucane Regional Park

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The assessment of the conservation status of taxa of conservation interest, such as the Italian hare (*Lepus corsicanus*) and the Italian roe deer (*Capreolus capreolus italicus*), is a key component of biodiversity management and conservation. These actions are particularly important in forest ecosystems of high natural value that are affected by disturbance factors such as domestic livestock grazing, which may contribute to habitat degradation and functional fragmentation, with potential effects on hare and roe deer populations. In this context, within the Gallipoli Cognato Piccole Dolomiti Lucane Regional Park (southern Italy), the two species were monitored as part of the Mo.Le.C.O.L.E. project (Monitoring Lepus and Capreolus: Long-range Observation of the Park Environment), with the aim of assessing population density, habitat use and ecological interactions, with particular attention to coexistence with free-ranging Podolian cattle.
Monitoring activities were conducted between October 2024 and October 2025 within the Gallipoli Cognato Forest Special Area of Conservation (SAC) IT9220130 (4,289 ha), subdivided into a 1 × 1 km sampling grid. Italian hare monitoring was carried out through the random deployment of 12 camera traps. The presence of *Lepus europaeus* was verified and suitable sites were identified for capturing *Lepus corsicanus* individuals, which were subsequently equipped with GPS–GSM collars. Interactions between wildlife and grazing cattle were analysed using spatiotemporal overlap models. Italian roe deer monitoring was conducted in six randomly selected sampling quadrants using thermal-imaging drones along transects spaced 100 m apart and replicated three times. Roe deer density was estimated using distance sampling in R (R Core Team, 2024) and compared with estimates obtained from camera trapping using the Random Encounter Model (REM), originally deployed for Italian hare monitoring. The degree of coexistence between wildlife and domestic livestock was assessed through spatiotemporal overlap analyses implemented in R.
Roe deer density estimated using REM was 1.66 ± 1.30 individuals/km² (CV 78%), whereas thermal drone surveys yielded an estimate of 2.61 individuals/km² (SE 1.39; CV 50%), indicating greater stability of estimates obtained through camera trapping. Temporal overlap analyses revealed moderate co-activity between roe deer and cattle (Δ = 0.62) and low overlap between hare and cattle (Δ = 0.27). Three GPS–GSM-collared Italian hare individuals exhibited differentiated home ranges and a strong selection for forest habitats (91M0), with secondary use of dry semi-natural grasslands (6210).
The integrated use of aerial thermography, camera trapping and satellite telemetry proved effective for monitoring low-density species, providing valuable information for adaptive management strategies. Results suggest a balanced coexistence between wildlife and domestic grazing, consistent with the stocking limit of 0.25 LU/ha/year established by grazing regulations and the Protection and Conservation Measures of the SAC. Potential critical issues are associated with the seasonal concentration of livestock near water sources during summer, highlighting the need for targeted monitoring and management actions.

N. 99

First photo-identification records of *Delphinus delphis* in the Gulf of Palermo: a contribution from Avvistiamo APS

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Photo-identification (photo-ID) is a widely applied non-invasive method to study cetacean populations, allowing individual recognition, long-term monitoring, and assessment of demographic structure. Despite its extensive use in several Mediterranean regions, structured photo-ID studies of the common dolphin (*Delphinus delphis*) remain absent from the Gulf of Palermo, where data on local occurrence and group composition are still limited. Here, we document the presence of *D. delphis* through the creation of the first individual photo-ID catalogue for this area. Visual surveys and opportunistic data collection were conducted by Avvistiamo APS between Capo Zafferano (east) and the Capo Gallo–Isola delle Femmine Marine Protected Area (west), with the support of citizen-science initiatives and local boat-tour operators. Between May and November 2025, 25 visual and acoustic surveys were carried out, totalling 112 hours of effort. *D. delphis* was observed once near Capo Mongerbino at a bathymetric depth of 124 m. During this encounter, standardised photo-ID procedures were applied to document natural and persistent markings (fin contours, notches, scars, and pigmentation), while drone-based photogrammetry provided additional accuracy in group size estimation and age-class assignment. Approximately 600 high-quality photographs were selected and processed, leading to the identification of 26 distinct individuals, coded Dd01– Dd26. Preliminary demographic assessment based on body proportions and fin morphology suggests that 6 individuals were adults, 16 subadults, 3 juveniles, and 1 newborn, indicating a socially structured group potentially including breeding components. This represents the first structured photographic documentation of common dolphins in the Gulf of Palermo. The catalogue provides a baseline for future re-sighting analyses, long-term monitoring, and Mediterranean-scale comparisons. Overall, the study improves understanding of *D. delphis* in a coastal area exposed to strong anthropogenic pressure and supports conservation planning at local and regional scales for effective future management actions.

N. 100

Early outcomes about the knowledge of mammal population in the Monte Rufeno - Selva di Meana district (central Italy): an example of collaboration between institutions and qualified citizen science

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Since 2010 the staff of Monte Rufeno Nature Reserve (Acquapendente – VT) began a permanent detection of the stable presence of a wolf population by means of wolf howling and camera trapping methodologies. There was immediately clear evidence that wolf pack's core area could be identified in the border zone between the Lazio and Umbria regions, thanks to the existence of the nearby Selva di Meana protected area (Allerona – TR). The presence of wolves triggered sound reactions in the social fabric, thus urgently encouraging collection of scientific data and communication of relevant objective findings within local communities. Main protagonists of these activities throughout the years have been Monte Rufeno Nature Reserve's conservation officers on the Lazio side, and a network of volunteers belonging to several associations gathered in the PAN Group on the Umbria side.
In the initial phase data collection was based on the use of opportunistically placed camera traps, together with wolf howling carried out in summer, in close cooperation. Over time camera traps enabled data collection on other priority mammals and provided information about populations' presence, distribution and trends within the district. By then, placement of camera traps has become more systematic, despite the lack of resources, and more coordinated, with data gathered in a study area of about 6.000 hectares that overlaps the two neighboring protected areas and some sites of Union importance (SAC and SPA); this area is divided on each side into squares of 1 or 2 kms wide, as sample units, according to the home range extension of the different species observed.
This study highlights the first results concerning population distribution and density of some mammal species of interest for conservation, such as wildcat (*Felis silvestris*) and polecat (*Mustela putorius*). Moreover, based on the relevant findings, collaboration for outreach activities aimed at improving citizens' and stakeholders' feelings about wildlife and natural environment is also displayed, together with the provision of damage prevention tools aimed at reducing social conflict.
The successful implementation of a constant collaboration network should also be pointed out. This network is gradually including monitoring and protection of other taxa (e. g. invertebrates, birds, reptiles, flora species) and the district habitats (particularly the Middle Course of the Paglia River – site of Union importance).
The work group consists of different entities belonging to different neighboring regions. Its main points of strength are based on the numerous and diversified skills and competencies, together with passion and deep sense of belonging to the territory of all its members.
This model should be supported and possibly exported. It can simply be described as a mixed system, participated by public institutions and what could be defined as "qualified citizen science".

N. 101

Bat communities in mountain regions respond to land-use in two ways: richness peaks at intermediate use, homogenization peaks in cities

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Mountain ecosystems are biodiversity hotspots but are increasingly affected by global change drivers, particularly climate warming and land-use intensification. At mid-elevations (≤ 2,200 m), expanding settlements, agriculture, and intensive forestry may act as strong environmental filters on mountain biodiversity. However, the combined effects of these latter pressures on highly mobile taxa, such as bats, remain poorly understood in mountain regions. Moreover, it is unclear whether local species richness adequately reflects these changes or whether underlying shifts in bat community composition remain hidden.
Here, we assessed how land use and elevation jointly shape bat α-diversity, β-diversity, and functional trait–environment relationships across a mid-elevation gradient in South Tyrol.
We conducted acoustic monitoring at 70 sites stratified across the elevational range below the treeline (~2,200 m). Sites spanned seven land-use types with increasing levels of anthropogenic disturbance, ranging from forests to cities, using the Distance-to-Nature index (D2N) as a proxy. We quantified taxonomic and functional diversity and applied RLQ and fourth-corner analyses to test trait–environment relationships.
Bat species richness peaked at intermediate levels of anthropogenic disturbance, with villages and croplands supporting the highest number of species, consistent with the intermediate disturbance theory. However, β-diversity revealed strong urban biotic homogenisation, as bat communities in city sites were highly similar to one another and dominated by widespread generalists, whereas forest sites showed greater differentiation in community composition. Villages shared urban-associated species with cities but additionally supported a broader species pool, including urban-sensitive bats. Trait analyses identified artificial light as the primary environmental filter separating light-tolerant urban bat communities from light-sensitive forest specialists. In contrast, elevation had no influence on species richness or community structure.
Our results show that land-use intensification is the dominant driver shaping bat communities in mid-elevation mountain landscapes, particularly affecting β-diversity and, to a lesser extent, α-diversity. The contrasting patterns of α- and β-diversity indicate that high local species richness can mask community homogenisation, highlighting the need for multiple biodiversity metrics, including trait-based approaches, under global change. Light tolerance and light sensitivity emerged as key traits structuring bat communities and should be incorporated into future trait-based studies. Villages may benefit bat populations by providing roosting opportunities while maintaining access to high-quality foraging habitats.

N. 102

Uncovering a breeding population of the greater noctule bat *Nyctalus lasiopterus* in southern Italy

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The giant noctule bat (*Nyctalus lasiopterus*) is one of the rarest and most elusive bat species in Europe. It is currently listed as Endangered (EN) in Italy and Vulnerable (VU) at the European level. In Italy, confirmed records are scarce and include both historical and recent observations, amounting to approximately twenty verified occurrences. These records are unevenly distributed and limited to Trentino-Alto Adige, Friuli Venezia Giulia, Veneto, Emilia-Romagna, Tuscany, Marche, Calabria and Sicily, with no recent confirmations from southern Italy and only one known reproductive colony currently documented in the province of Udine. The species' ecology, distribution and population dynamics remain poorly understood, largely due to its elusive behaviour and the difficulty of detecting it using standard monitoring techniques. Within the framework of a nationwide bat monitoring programme conceived by ISPRA (Italian Institute for Environmental Protection and Research) and founded by the Ministry of Environment and Energy Security, surveys integrated passive acoustic monitoring using ultrasonic bat detectors with active capture sessions conducted with mist nets. In Sila National Park (Calabria), mist nets were deployed approximately two hours after sunset at a drinking site located along the edge of an extensive forest dominated by Calabrian black pine (Pinus nigra subsp. laricio), a habitat considered suitable for the target species. The presence of *N. lasiopterus* was confirmed in the Sila National Park through the capture of ten individuals, including three post-lactating females, adult males and juveniles. These data provide strong evidence for the existence of a breeding population within the park, representing the second confirmed reproductive population currently known in Italy and the first recently documented in southern Italy. The finding supports the hypothesis that the species may persist undetected for long periods in suitable habitats, even in areas where it was historically recorded but subsequently unconfirmed. *N. lasiopterus* is considered a partially migratory species, although some populations appear to be resident, as documented in northeastern Italy, where individuals have been recorded year-round. The discovery of a breeding population in the Sila National Park is therefore of high conservation relevance, contributing valuable information to the limited knowledge of the species' ecology and spatial dynamics in Italy. Habitat loss, particularly the removal of old-growth forests and mature trees with suitable cavities, along with the expansion of wind energy facilities, threatens this species. Given the difficulty of detecting *N. lasiopterus*, this study highlights the necessity of targeted, species-specific monitoring approaches to accurately assess its distribution and conservation status. Focused surveys using appropriate techniques are essential to improve knowledge of this elusive bat and to support effective conservation strategies.

N. 103

Italian National Parks as areas for bat conservation: a national monitoring programme

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What is the current status of threatened bat species in the Italian National Parks? Do these protected areas contribute effectively to their conservation? And how can long-term monitoring schemes be designed to generate robust and comparable data over time? A nationwide monitoring programme for bats was implemented across Italian National Parks to answer these questions. The project, conceived by ISPRA (Italian Institute for Environmental Protection and Research) and founded by the Ministry of Environment and Energy Security, aims to update knowledge on species distribution and status, with particular attention to species sensitive to environmental change. Monitoring activities were carried out in all 24 Italian National Parks using a standardised, multi-method approach. Acoustic monitoring was conducted at 618 sampling sites, corresponding to an average density of one site about every 20 km² of suitable habitat. Recordings were performed for two full nights in two seasonal phases (late spring–summer and late summer–autumn), following standardised temporal and environmental constraints. Species identification was carried out using automated classification followed by expert validation. Temporary capture sessions were conducted at 185 sites using mist nets placed in suitable microhabitats, allowing the collection of biometric, demographic and reproductive data and the identification of cryptic or acoustically indistinguishable species. In addition, known roosts were monitored, focusing on both reproductive sites and hibernacula, using non-invasive counting techniques adapted to seasonal conditions. Pressures and threats were systematically recorded at each site following the Art. 17 Habitat Directive classification. The standardised protocol across the national park system resulted in a large and homogeneous dataset covering diverse ecological and biogeographical contexts. Results reveal high bat species richness within protected areas and confirm the central role of National Parks in supporting populations of species of community interest, including several threatened taxa. The integrated use of acoustic surveys, captures and roost monitoring substantially reduced knowledge gaps on species presence, distribution, and seasonal habitat use, while site-specific criticalities related to habitat fragmentation, anthropogenic pressures, and climate-related factors were identified. Overall, the project provides a robust baseline for future assessments of population trends and conservation status, and the combination of biological and threat data lays the foundation for long-term monitoring frameworks to support adaptive management and effective conservation strategies for bat communities under ongoing environmental change.

N. 104

Predicting Habitat Suitability of the coypu (*Myocastor coypus*) in Italy

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The coypu (*Myocastor coypus*) is listed as a species of European Union concern under the EU Regulation 1143/2014. Consequently, identifying areas that are potentially suitable for this species is a key step in supporting and optimizing ongoing management and control actions. Despite the widespread presence of the coypu in Italy, the current scientific literature lacks national-scale Species Distribution Models (SDMs) for this species. To address this gap, we applied an SDM approach to estimate the potential current distribution of the coypu across Italy. A total of 821 occurrences from 2015 to 2025 were retained from GBIF (Global Biodiversity Information Facility) and 11 environmental predictors, including topographic, climatic and land use variables were used to perform ensemble habitat suitability modelling. The ensemble models included Maximum entropy (Maxent), Generalized Boosted Models (GBM) and General Linear Models (GLM) were used.
The final ensemble model showed good performance, with an AUC score of 0.90 and a TSS score of 0.66. Key predictors influencing city habitat suitability were slope, distance from urban areas and the minimum temperature of coldest month (Bio6).
Our research highlighted the potential distribution of the coypu in Italy at a national scale, showing that the most suitable habitats are influenced by anthropogenic landscapes, topography, and low temperatures, which is consistent with the ecology of the species. Additionally, the model predicted potential suitable areas in parts of central and southern Italy where occurrences are presently absent but were colonization is likely. These results can support the identification of priority areas for monitoring and management efforts. Further research should focus on habitat connectivity and on assessing potential shifts in coypu distribution under future climate scenarios.

N. 105

Important bat maternity colonies in buildings: managing conflicts and regulatory issues

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Almost all Italian bat species are known to use buildings as roosts. From a conservation perspective, this is particularly relevant in the case of breeding colonies of species listed in Annex II of the Habitats Directive and/or included among threatened species (IUCN). According to the law, bats must not be disturbed, their breeding sites must not be damaged or destroyed, and those that host species listed in Annex II of the Habitats Directive may warrant inclusion in the Natura 2000 network—a possibility that, however, has been scarcely exploited in Italy.
The presence of bat colonies in buildings can cause problems: for bats (hostility from people, often driven by fear; impacts on individuals and roosting sites caused by building works and/or changes in use) as well as for humans (because of droppings, triggering of alarm systems, etc.). In the absence of appropriate management measures, legal provisions for bat protection are likely to be violated.
We present several case studies addressing how to reconcile the needs of bats and humans. They involved maternity colonies of *R. ferrumequinum*, *M. blythii*, *M. capaccinii*, *M. emarginatus*, *M. myotis*, and *P. macrobullaris* in northwestern Italy.
In order to plan management strategies, it was crucial to understand how bats used the buildings. This was done by identifying the period of their occurrence, their spatial distribution within the site (data obtained through repeated visits), and the access points they used, which were often detected by surveying potential accesses using thermal imaging or IR LED cameras. The latter were also employed to census the colonies so as to monitor the effectiveness of the actions implemented (counts before, during, and after the actions).
We present case studies that required adjustments to the planned schedule of restoration works, the relocation or reduction of colony roosting sites, and changes in the access points and transit routes used by the bats. When properly addressed, the problems were resolved, whereas simplistic solutions failed the goal.
Overcoming conflicts between bats and humans is possible, provided sufficient time (as some changes require bats to adapt) and appropriate chiropterological expertise (i.e. knowledge of the habits of bat species).
Obviously, a prerequisite for implementing the protection and management of colonies is being aware of their presence. This is currently hindered by several factors. The law does not mandate reporting the presence of colonies, and the penalties for offences against bats are inadequate (a tightening of penalties is under discussion in the Italian Parliament); such factors may encourage deliberate harmful behaviour without it coming to light. Furthermore, although legislation establishes that biodiversity conservation is carried out for the collective benefit, no incentives are provided to offset the potential conservation costs borne by those who host bats, let alone to make the presence of bats economically advantageous. We therefore call for engagement with policymakers to introduce mandatory reporting of colonies identifiable as potentially of high conservation interest (i.e. associated with large-volume roosts), at least in the case of publicly owned buildings; and for the establishment of incentive schemes (e.g. tax breaks) to make the presence of similar colonies economically advantageous, at least in the case of privately owned buildings.

N. 106

Contribution to the knowledge of the chiropterofauna of the Aeolian Islands through bioacoustic monitoring

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The composition of the Italian mammal fauna is characterised by a predominance of taxa belonging to the order *Chiroptera*. In Sicily, for instance, 50% of the regional terrestrial mammal species are classified as bats. Despite the recognition of 24 species-level taxa based on current knowledge, this order remains unique among Sicilian mammals for which the precise number of species remains uncertain. The available data regarding the distributional patterns of chiropterans in the Aeolian Islands, a circum-Sicilian archipelago in the northeast and the focus of this study, remains far from exhaustive. A comprehensive review of the literature from the past four decades reveals a range of taxa from a minimum of one to a maximum of six. The most recent update, dating to 2025, confirms the presence of four species in total, with an insular distribution varying between one and four species per island. Given the high naturalistic potential of the Aeolian archipelago, its proximity to the mainland and the active flight capabilities of bats, it is highly probable that the species richness of each island exceeds current literature records. Nevertheless, it is imperative to establish a precise definition of the Chiropterofauna composition for each island, as this constitutes a fundamental prerequisite for effective local biodiversity conservation. It is evident that checklists represent a critical operational tool for the planning and implementation of effective faunal management and conservation strategies.
The detection of bat presence was carried out through acoustic sampling during July, August and September of 2024 and 2025 using AudioMoth devices. The following recording intervals were programmed: in 2024, devices were activated for 40 minutes per night (20:00-20:10, 21:00-21:10, 23:00-23:10, 6:00-6:10); in 2025, sounds acquisition covered a twelve-hour span, beginning one hour before sunset and concluding one hour after sunrise. A preliminary analysis of the acoustic data was performed using Kaleidoscope Pro v. 5.7.0 (Wildlife Acoustic, USA), utilizing default settings for automated identification to discriminate recordings containing bat sonar emissions from those that did not. The signals were manually analysed using BatSound software (Pettersson Elektronik AB), with the aim of measuring four key parameters for species identification: the frequency of maximum energy, the start frequency, the end frequency and pulse duration.
The bioacoustics surveys identified the presence of six species; however, the classification of one species remains uncertain. At present, five species have been confirmed to be present: *Hypsugo savii*, *Pipistrellus kuhlii*, *Pipistrellus pipistrellus*, *Rhinolophus ferrumequinum* and *Tadarida teniotis*. The species richness values for each island are as follows: Alicudi (4), Filicudi (4), Lipari (6), Panarea (4), Salina (6), Stromboli (4) and Vulcano (6).
Considering the global vulnerability of the order, with over a third of bat species assessed by the International Union for Conservation of Nature (IUCN) as threatened or data deficient, the implementation of distributional data of bats on these islands was of fundamental importance, in order to support more effective management and protection strategies. It is deemed necessary to update the Standard Data Forms of the Special Areas of Conservation (SACs) that cover the territory. Specifically, the formal integration of the Greater Horseshoe Bat (*R. ferrumequinum*) into the conservation targets is recommended, as it is a reference taxon for SAC designation under Annex II of the Habitats Directive. Furthermore, the inclusion of all the aforementioned taxa in the Standard Data Forms is proposed. As these species are listed in Annex IV of the same Directive, they are subject to a regime of strict protection across the entire territory.

N. 107

Mammal density in a sample area of an Comprensorio Alpino dell'Alta Valle di Susa (Piedmont, Italy) assessed using camera traps

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Knowledge of the structure and size of a free-ranging wild population is a fundamental requirement in wildlife and game management. These two parameters are estimated through both direct and indirect techniques. In recent years, the use of camera traps has increasingly expanded in several fields, including ecology and behavioural studies, thus proving to be a useful tool also for management purposes. Within this framework, the Random Encounter Model (REM) was applied in an area of the Alta Valle di Susa Alpine Hunting District (CATO2). The target species were red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*), and red fox (*Vulpes vulpes*). Between September and November 2025, 44 camera traps were deployed following a regular grid design within a sampling area extended 3046 ha of the CATO2. All images were processed using Agouti software. A total of 12,844 observations were collected, of which 7.2% were red deer, 4.2% roe deer, 0.53% wild boar, and 1.36% red fox. The estimated densities, considering all age classes, were 4.6 individuals/km² (CI = 3.1–6.9, SE = 0.9, CV = 0.2) for red deer, 8 individuals/km² (CI = 5.3–12.2, SE = 1.7, CV = 0.21) for roe deer, 0.19 individuals/km² (CI = 0.08–0.45, SE = 0.09, CV = 0.5) for wild boar, and 1.1 individuals/km² (CI = 0.7–1.9, SE = 0.3, CV = 0.3) for red fox. The protocols adopted were those developed within the European Observatory of Wildlife (EOW), as part of the broader ENETWILD project promoted by EFSA. This approach enabled the sharing of collected data at the European scale.

N. 108

How many wild boar are too many? Using camera traps to support management decisions at Lago di Vico Natural Reserve

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The wild boar (*Sus scrofa*) has undergone a significant demographic and geographic expansion across Europe, driven by its remarkable ecological plasticity and high reproductive potential, expansion of woodlands and increasing availability of food in anthropized landscapes. In protected areas, managing this species has become a critical priority, but also to reduce human-wildlife conflicts, in particular regarding damage to crops caused by wildlife, of which wild boar is often the main actor.
This study aims to estimate the abundance of the wild boar population within the Lago di Vico Natural Reserve using a systematic camera-trapping design. The research specifically focuses on analysing the population's age-class composition and evaluating the effectiveness of camera trapping as a reliable method for age-class discrimination of wild boar. A 2x2 km grid was applied across the entire Reserve, and 20 camera traps were randomly placed within each grid cell. Monitoring was conducted from January to April in 2025 and is currently ongoing for the same period in 2026, with cameras set to photo mode and positioned at approximately 30 cm above ground. To ensure comparability, all devices were installed in the same locations during the second year. Images were processed through the *Wildlife Insights* platform for automated species identification and population analysis.
Wild boar density was estimated using *Random Encounter Model* (REM) Based on an effective study area of 75 km² (excluding 5 km² of water surfaces), the 2025 analysis yielded a density of 20.4 ind./km² (95% CI: 14.4 - 27.8 ind./km²), resulting in a total population estimate of 1427 individuals (95% CI: 1004 - 1948 individuals into the Reserve). Adults accounted for 81% of total detections, with juveniles representing 13% and unknown individuals 6%. During the same year, a management cull removed a total of 190 individuals, consisting of 89 adults, 41 juveniles (red-coats), and 60 piglets (striped-coats). The same camera trap locations were used in the 2026 monitoring session to assess the population's response to the removal.
The comparison between the two monitoring years will underscore the importance of long-term, standardized camera-trapping protocols for detecting changes in abundance and shifts in population age structure. Overall, this approach provides a valuable approach for informing adaptive management strategies in protected areas where wild boar populations require continuous assessment and control.

N. 109

Are we considering environmental parameters in the war against wild boar?

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Around 10,000-12,000 years ago, the genus *Homo* "invented" agriculture in various parts of the globe. Encouraged by post-glacial climate changes and the established familiarity with the continuous use of wooden tools, agriculture marked the transition from a nomadic lifestyle (hunting/gathering) to a sedentary one, based on the domestication of plants (cereals and legumes) and animals (dogs, horses, sheep, goats, cows, and pigs). Inventing agriculture meant imposing recurring and predictable cycles, synchronous production, and high yields on productive plants and livestock. In other words, more ecologically, it meant „laying out" a rich table of food. For wildlife with highly plastic characteristics such as *Sus scrofa*, the agricultural field can become a supplementary/alternative source of food. Over the last decades, *Sus scrofa* populations have expanded markedly throughout Europe. Today, the wild boar (*Sus scrofa*), although a mammal native to Eurasia, is widespread on all continents, except for Antarctica. In Italy, forest cover increased from approximately 12% at the beginning of the 20th century to nearly 40% today. Since 1990, more than one million hectares of forest have been gained, mainly due to agricultural land abandonment and rural depopulation. This process has promoted the recovery of mature woodland stands, often dominated by mast-producing species, and reduced livestock grazing pressure. At the same time, the widespread cultivation of high-energy crops provides additional trophic resources. These landscape and land-use changes have substantially increased habitat suitability and carrying capacity for wild boar. Nevertheless, population control strategies are still largely based on recreational hunting and reactive measures implemented in response to sanitary emergencies. In this scenario of species increase, population control is based on only two approaches: reactive management to control local epidemics and proactive management of wild boar populations on a larger geographic scale, achieved through shooting. Intensive killing (nowadays not so silent) of wild boars can contribute significantly to the control of local outbreaks, and larger wild boar-free buffer zones could work in contexts of frontal disease expansion or to protect key pig farming centers. Although we can describe various environmental and ecological factors that drive the expansion of *Sus scrofa*, we mainly rely on recreational hunting to control the wild boar population While hunting can locally reduce densities and contribute to disease containment, it does not directly address the environmental drivers sustaining population growth. Long-term management effectiveness may therefore depend on integrating wildlife control with territorial planning, forest management and agricultural policies capable of influencing habitat structure and resource availability.
Current approaches only partially incorporate these environmental parameters. A more comprehensive framework is needed in order to establish a link between population control and landscape-scale ecological processes.

N. 110

Understanding interspecific interactions of small mustelids in mountain communities using structural equation modelling

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Understanding interspecific interactions among mammalian carnivores is essential for conservation biology, yet the drivers of these interactions are often complex and challenging to disentangle. Small mustelids of the genus *Mustela* play a crucial ecological role as specialized rodent predators, influencing vole population dynamics, while at the same time being highly vulnerable to predation by larger carnivores. Despite their importance, small mustelids remain among the least-studied carnivores due to their small body size, low natural densities, and elusive behaviour. Consequently, our understanding of how they navigate interspecific interactions within mammal communities is still limited. In this study, we used structural equation modeling (SEM) to investigate the network of interactions involving the stoat (*Mustela erminea*), the least weasel (*Mustela nivalis*), their potential predators and competitors, including the pine marten Martes martes, the stone marten *Martes foina*, and the red fox *Vulpes vulpes*, their primary prey (such as the snow vole *Chionomys nivalis*, the bank vole *Clethrionomys glareolus*, and the garden dormouse *Eliomys quercinus*), and relevant environmental variables in the Alpine habitat.
Fieldwork was conducted in the Maritime Alps Natural Park (northwestern Italy) between May and October 2024, using two different camera-trapping setups, according to elevation. To capture the transition from closed forest habitats to more open meadow and rocky environments, we surveyed 60 grid cells (1 × 1 km) above 1,600 m a.s.l. and 60 cells below this threshold. At lower elevations, we used external camera traps, whereas at higher elevations, we deployed the Alpine Mostela, an enclosed camera-trap system consisting of a plastic box with an internal camera and an open 9 cm Ø open tube, specifically designed to enhance detection of small mustelids. To estimate the relative strength of direct and indirect pathways among species and environmental variables, we developed two ecological models corresponding to the two environments and sampling approaches: an open- habitat model and a closed-forest habitat model.
In the open-habitat model, we detected a strong positive association between the stoat and the stone marten (mean posterior distribution of 3.51, 90% CRI [1.19, 6.71]). In contrast, stoat occurrence exerted a strong negative effect on the garden dormouse (mean posterior distribution of –13.96, 90% CRI [–40.95, –2.44]) and showed a positively association to rock cover (mean posterior distribution of 3.18, 90% CRI [1.57, 5.77]). In the closed-forest habitat model, the least weasel was negatively associated with the pine marten (mean posterior distribution of –2.40, 90% CRI [–5.76, –0.46]) and the red fox (mean posterior distribution of –1.18, 90% CRI [–3.44, 0.19]), while showing a positive association with the stone marten (mean posterior distribution of 0.97, 90% CRI [–0.08, 2.38]). No significant relationships were detected between the least weasel and its prey species or environmental variables.
Our results highlight the importance of interspecific interactions in shaping the occurrence of small mustelids across mountain habitats. The unexpected positive associations between small mustelids and the stone marten may indicate spatial coexistence in areas of high prey availability and potential temporal niche partitioning to reduce predation risk. In contrast, negative associations between the least weasel and larger mesocarnivores in forested habitats likely reflect both intraguild predation and competition for rodent prey, particularly with the pine marten. Despite some limitations, including our focus on a subset of species within a larger ecological community and reduced detectability of foxes at higher altitudes associated with the use of Alpine Mostelas, this study emphasizes the need to account for complex multispecies interactions when assessing mesocarnivore communities.

N. 111

A game of risk: human activities shape roe deer spatial behavior in the presence of wolves

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In human-dominated landscapes, human activities shape prey spatial behavior, creating complex landscapes of risk, where prey simultaneously cope with threats associated with natural predators and multiple human activities. In such contexts, human disturbance can profoundly alter predator–prey interactions, reshaping spatial behavior. In this study, we investigated how the interplay of hunting, human infrastructures, and recreational activities, in the presence of wolves, influence habitat selection of roe deer (*Capreolus capreolus*), inside and outside a protected area, in a mountainous area of the southwestern Alps characterized by high wolf presence and human disturbance.

We analyzed GPS data from 11 roe deer monitored between 2022 and 2024 using third-order Resource Selection Functions. Generalized Linear Mixed Models were used to compare used and available locations within individual home ranges, accounting for individual variability. Habitat selection was evaluated in relation to environmental variables, anthropogenic features (distance to buildings, roads, and trails), hunting risk, wolf density, and temporal variation associated with different hunting periods (before vs. after) and hunting modes (roe deer hunting vs. wild boar drive hunts), allowing us to assess both the overall effect of hunting and the differential effects of distinct hunting strategies on roe deer habitat selection.

Roe deer strongly selected areas with high tree cover, confirming the role of forested habitats as key refuge areas. During the hunting season, and particularly during wild boar drive hunts, roe deer increased their selection for proximity to buildings, supporting the human shield hypothesis. At the same time, individuals shifted from avoiding areas of high wolf density before hunting to selecting them during hunting periods, especially during drive hunting, suggesting that hunting-related disturbance could alter the spatial overlap between prey and predators. Within the protected area, roe deer showed stronger avoidance of trails, likely reflecting higher recreational pressure.

Our findings reveal the complex trade-offs roe deer face when navigating multiple risks in human-modified landscapes. Hunting practices, recreational activities and predator presence can jointly shape habitat selection, highlighting the importance of considering cumulative and interacting disturbances in wildlife management. Understanding prey responses to overlapping human and natural pressures is essential for effective management and the development of sustainability strategies in increasingly human-dominated alpine landscapes.

N. 112

Marking Under Pressure: How Bear Density Shapes Chemical and Visual Signalling

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Animal communication is a key component of animal ecology. In mammals, chemical signalling is the primary channel, though visual and acoustic cues also play important roles. While many studies have explored the seasonality and individual status associated with mammalian marking behaviours, little is known about how conspecific density shapes their occurrence, duration, and activity patterns. Here, we tested whether the intensity and temporal dynamics of marking behaviours are density dependent. Using camera traps, we monitored brown bear *Ursus arctos* marking behaviours (rubbing, pedal marking, and tree debarking) at 14 trees across nine mating seasons (2016–2024) in the Cantabrian Mountains, northwestern Spain. Cameras operated continuously (24 h/day) for 122 monitoring days per tree per year, yielding 1,708 tree-days annually and a total of 15,372 tree-days. Our findings reveal that pedal marking, a male-exclusive behaviour, increased both in occurrence and duration with higher conspecific density, suggesting a density dependent role in mate attraction and dominance signalling. Moreover, all different marking behaviours shifted toward more diurnality as the number of different bears increased. This indicates that bears may adjust their marking activity toward riskier daytime periods in human-modified landscapes, as male–male competition for mates intensifies. Overall, our study provides novel evidence that conspecific density can modulate the intensity and timing of communication behaviours, offering new insights into why brown bears employ a diverse repertoire of marking strategies during the mating period.

N. 113

The distribution of Red Deer and Roe Deer in Basilicata

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The presence of the Red Deer (*Cervus elaphus*) in Basilicata is relatively recent and is mainly the result of reintroduction projects carried out by the Basilicata Region and the Pollino National Park. As for the Roe Deer (*Capreolus capreolus*), its current distribution derives both from reintroduction projects implemented by the Basilicata Region and the Province of Matera, and from the natural expansion of populations present on the Calabrian side of the Pollino National Park toward the Lucanian side.
This contribution presents an initial mapping of the regional distribution of Red Deer and Roe Deer. Data were collected between 2017 and 2025 using an integrated approach that included camera trapping, roaring surveys, searches for signs of presence, spotlight counts along linear transects, and opportunistic records provided by qualified observers (guides and naturalists), supported by photographic evidence and subsequently validated by the authors. The integration of these different techniques served solely to produce an initial distribution map of the two species, without providing estimates of abundance or density.
The study area was divided into quadrants using a UTM grid with 10 km cells. At least one monitoring technique was applied within each of the quadrants significantly falling inside the regional territory (n = 111). The presence of Red Deer was confirmed in 32 quadrants (28.8% of the sampled area), and Roe Deer in 28 quadrants (25.2%), with 13 quadrants (11.7%) showing the presence of both species.
The results show that the Red Deer is now well established along the entire Lucanian Apennine ridge, with particularly consolidated nuclei within the Pollino and the Appennino Lucano Val d'Agri Lagonegrese National Parks. Northern populations show lower ecological continuity with central–southern ones, suggesting a distinct nucleus. The Roe Deer, on the other hand, exhibits lower densities, with a fragmented but expanding distribution originating from historical presence areas and reintroduction sites, occupying mainly forest habitats, ecotonal zones, and wooded pastures.
This study provides a fundamental knowledge base for planning management and conservation strategies for cervids in Basilicata, offering the first comprehensive overview of their regional distribution.

N. 114

The European Observatory of Wildlife: streamlining the approach to monitoring wildlife populations at a continental scale

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The need to harmonize the monitoring of wild mammal populations at international level to assess risks associated to shared emergent diseases and develop science-based polices has led to the creation of the European Observatory of Wildlife (EOW), a continental framework for wildlife monitoring. The EOW, as part of the ENETWILD Consortium funded by the European Food Safety Authority (EFSA), is conceived as a network of monitoring sites where common protocols are implemented for a transnational, integrated and harmonized monitoring of wildlife species and their pathogens in Europe. The EOW provides collaborators with training, protocols for estimating wildlife density, continuous assistance on study design, implementation in the field, data processing and networking activities.
The EOW has streamlined a collaborative approach to estimate the local density of mammal species, implementing the random encounter model (REM) method, based on camera trapping. The protocol in use combines a standardised study design and photogrammetry, that allows a three-dimensional reconstruction of camera trap scene for calculating essential REM parameters like activity, instantaneous speed and day range. The workflow highly relies on Agouti, a platform offering a complete solution for storing, managing and processing camera trap images. The final creation of a standard export file (camtrapDP format) allows the automation of the downstream steps of data analysis using provided R codes, leading to the production of perfectly harmonized density estimates (accompanied by their precision values).
Since 2021, ENETWILD stakeholders have employed the EOW protocol to assess densities of species like wild boar, roe deer, and red fox across Europe. Since its first campaign in 2021, 103 study sites have been monitored over 32 different countries with density estimates showing interannual stability with refined precision across several monitored populations. In 2024, network expansion included 37 institutions monitoring 59 sites across 23 countries, prioritizing areas affected by African Swine Fever (ASF): 9 sites were in infected areas and 9 were at <100 km from the ASF frontline.
The expansion of EOW network aims to improve continental data representativeness, especially in regions where emerging diseases like ASF and Avian Influenza pose significant risks.
EOW data supports continental-scale risk analysis, providing harmonized density estimates essential for abundance modelling and aims to contribute to future schemes of biodiversity

monitoring in Europe. Consistent multi-year data collection across diverse ecological conditions will ensure comprehensive trend data for effective risk assessment and wildlife management. Furthermore, in accordance with the EU recommendations on open science, the EOW makes the estimates publicly available to stakeholders and to the scientific community. In fact, all the results obtained from the network activities during the different annual campaigns, are shared in an open access database on Zenodo, making them usable worldwide. Ongoing networking efforts and outreach activities link EOW with other wildlife monitoring and disease-prevention initiatives, enhancing collaboration and maximising the reach of the results obtained. Through its activities, the EOW is becoming a reference network in Europe, refining its density estimation approach year after year and aiming to integrate it with protocols for pathogen detection, so as to represent a widespread surveillance system to monitor emerging diseases and host populations.

N. 115

Genetic structure and introgression patterns in the expanding wolf population of Tuscany

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The expansion of the wolf (*Canis lupus*) population in Italy has increased interactions with dogs in human-modified landscapes, raising concerns about anthropogenic hybridization and possible erosion of the wild gene pool. This study aimed to assess the population genetic structure and patterns of introgression from domestic dogs over a 30-year period (1988-2018) across an area spanning the region of Tuscany and its surroundings. Genetic analyses were conducted on 4600 invasive (tissues and blood) and non-invasive (faecal) samples, yielding 584 unique wolf genotypes. A panel of 12 polymorphic autosomal microsatellites (STRs) was used for individual identification, population-level analyses and, supplemented by up to four Y-STRs, mtDNA control region sequencing and the K-locus associated with black coat in dogs, for the ancestry analysis. Individuals were assigned to wolf or hybrid categories, based on ancestry coefficients (qw), derived from a Bayesian clustering analysis (STRUCTURE), including reference panels of pure wolves and dogs. To prevent bias due to the presence of related individuals, a grid-based random selection of individuals was used to assess population genetic structure by multivariate and Bayesian approaches. Moreover, spatial-temporal trends were assessed by grouping genotypes into 5-year time periods and three altitude classes (mountain, hill, plain) and using AMOVA and landscape genetic approaches (sPCA, Mantel tests). Changes in allele frequencies, genetic diversity and levels of introgression (qw) were also assessed by permutations tests. The results revealed that genetic diversity was comparable to that of other Apennine populations, with a slight temporal increase in allelic richness. STRUCTURE analysis detected no population substructure suggesting high gene flow level; AMOVA and sPCA revealed weak but significant altitudinal genetic structuring, consistent with a slight coast-Apennine differentiation. Bayesian analysis identified around 30% of all individuals as hybrid/introgressed, with significantly higher levels of dog introgression in lowlands than at higher elevations, as revealed by differences in mean qw values and frequency of canine alleles. Introgression signals were stronger in uniparental markers: although almost all individuals showed an Italian wolf mtDNA, canine Y-haplotypes (YH5, YH8, YH34) showed notable frequencies and spatial clustering, suggesting directional mating (male dogs × female wolves). The dog-derived Kb allele was also frequent in introgressed individuals, always in heterozygosis. Overall, no significant increase in the levels of introgression was detected over time. Altogether, these findings reveal widespread, but low-intensity introgression, with canine alleles persisting across generations despite rare hybridization events. The absence of a marked population structure might reflect high dispersal, while the altitudinal cline in introgression supports the link between hybridization and human presence. An integrated genetic-phenotypic monitoring, relying on carcasses and camera trapping, should be considered in the future to complement genetic information with data useful to assess possible phenomenon of adaptive introgression and understand long-term dynamics and implications of canine introgression in this wolf population.

N. 116

High densities of marmots in the Vezzena plateau (Levico, Trentino) and responses to tourism stress

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Marmota marmota plays an exemplary ecosystem role in the Alpine ecosystem. Its role as an ecosystem-building species is reflected in the selection of grazing species in the meadows where it forages, its value as prey for top predators in those environments, and the changes to fertility and structure caused underground by its burrows, vast underground systems also essential for the social hibernation that characterizes the marmot. In this context, the distribution and characteristics of marmot burrow systems were studied in the context of the Vezzena plateau, in Levico Terme municipality, where the species reaches particularly high densities, in addition to evaluating the effects of tourism on the species' surveillance activities.
The burrows were studied through direct surveys and collection of ecological data, including location, type of use, size, and relationships with orographic variables, to identify potential ecological and behavioural variables that influence their distribution.
The Vezzena Pass area has only recently been colonized and boasts some of the highest population densities in the Alps, partly due to the rich flora of the plateau, with fertile meadows available to the rodent. Analysis of the burrow distribution allowed us to assess the increase in rodent presence based on known historical data, as well as assess densities and family group structure.
In three spatial subunits we found 14.4, 8.6 and 14.5 burrows per hectare, for a total number of approximately 11.7 burrows per hectare, one of the densest recorded.
The adaptation of families located near trails and experiencing frequent but low-intensity disturbance is also clear. Indeed, the occurrence of a musical event had a severe impact on all groups, causing readjustment times exceeding a day. This information increases our understanding of the species and provides important data for the management of this protected rodent.

N. 117

Mammals in the Nonantola (Modena) plain: role of the remaining small wooded areas

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Maintaining wooded oases in the Po Valley, an increasingly urbanized area where agriculture is taking on industrial characteristics, is a priority in a medium- to long-term conservation policy. The Torrazuolo oasis, located near Nonantola (Modena province), in an otherwise intensively farmed area with a dense peri-urban and industrial mosaic, has significant naturalistic value. The aim of the study is to evaluate how this area plays a role in the conservation of mammal communities, also based on a census of local populations over 25 years ago.
The presence data come from direct observations of presence and from the analysis of approximately 700 Barn Owl prey items from sites on the edge of the wooded area and from localities in the same municipality characterised only by the agricultural and peri-urban mosaic. 12 species of small mammals have been found, compared to 13 in the past: *E.europaeus*, *T.europaea*, *C.leucodon*, *C.suaveolens*, *S.etruscus*, *S.samniticus*, *M.avellanarius*, *M.arvalis*, *M.savii*, *A.sylvaticus*, *R.norvegicus*, *R.rattus*. Considering the community revealed by prey analysis close and far from the protected wooded area, *M.savii* is anyway the dominant prey (61,5 vs 74 %) followed by *A.sylvaticus* (6,4 vs 9 %) and a strong difference in the predation on *M.arvalis* (9,4 vs 1,8). 10 are the species predated in sites close to the wood and 8 in agricultural and open sites.
The presence of *M.avellanarius* is limited to the woods and hedgerows around the Torrazuolo, while the *S.samniticus* appears to be able to find refuge even in the rival trees along the ditches. Compared to censuses from 25 years ago, there are no records of the Arvicola italicus, Neomys fodiens and *Micromys minutus*. The absence of Mus domesticus in the analysed sample is likely due to the completely agricultural context of the locations. The number of rats of both species is very low. In addition, the presence of *Glis glis* and *Sciurus vulgaris* appears to derive from the not well considered releases by a local wildlife rescue centre of individuals recovered from the hilly areas of the province, even if the squirrel is increasing in the lowland areas in the current phase of expansion of the species.

N. 118

Towards resolving species-level plant diets in Alpine wildlife through shotgun sequencing

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Accurate diet characterization is fundamental to understanding the ecology, habitat requirements, and health of wildlife in sensitive alpine ecosystems. While DNA metabarcoding of fecal samples has become a standard tool, it often lacks the taxonomic resolution required to distinguish between closely related plant species. In this study, we evaluate a methodological framework based on shotgun sequencing to achieve species-level resolution in plant diet analysis, providing a high-precision alternative for monitoring mountain-dwelling wildlife.
Our approach is currently being developed and validated using fecal samples from the rock ptarmigan (*Lagopus muta*), a high-altitude specialist that serves as a model for testing dietary resolution in alpine flora. We evaluate the performance of shotgun sequencing together with the Kraken2 classifier across different reference database configurations, including full genomes, chloroplast markers, and Internal Transcribed Spacer (ITS) sequences. A key component of our work involves the enhancement of available reference databases through the integration of the latest sequences from NCBI-GenBank in a quality-controlled and curated manner, ensuring the highest possible taxonomic coverage today for alpine-specific taxa and beyond.
Preliminary results highlight the critical role of database selection in taxonomic assignment and the ecological insights gained through co-occurrence network analysis. We demonstrate that shotgun metagenomics allows for the parallel identification of plant content and bacteria within the same fecal samples. Interestingly, our co-analysis suggests a functional link between diet and the gut microbiome. Specifically, we found that certain medicinal plants, such as *Lavandula angustifolia*, negatively correlate with potentially pathogenic bacteria, suggesting a possible role in modulating animal health. Additionally, the detection of specific bacteria such as *Pseudomonas putida* serves as an indicator of habitat quality and soil stress. Furthermore, the presence of plant pathogens like *Rhizobium tumorigenes* across habitats demonstrates the potential for the simultaneous monitoring of animal health and plant-ecosystem integrity.
This shotgun-based approach offers a scalable and high-resolution alternative for studying the dietary ecology and potential health implications for wild animals. By refining these bioinformatic methods in a controlled alpine model, we provide a robust toolset that is highly transferable to the conservation and management of alpine mammals, such as the Alpine chamois or the mountain hare, where precise knowledge of host-diet-microbiome interactions is vital for ecosystem resilience.

N. 119

From threat to opportunity: roadkill records improve knowledge of *Lutra lutra* distribution in Calabria

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The European otter (*Lutra lutra*) is a semi-aquatic carnivore of high conservation value and is widely regarded as a bioindicator of the ecological quality of river systems. Following a marked decline in Italy during the 1970s and 1980s, mainly due to pollution, habitat loss and direct persecution, the species is currently showing a gradual recovery and recolonization of its historical range. Nevertheless, populations remain fragmented and vulnerable. In this context, road mortality represents one of the main current threats, particularly for peripheral and expanding populations, and plays a key role not only as a local limiting factor but also as an indirect indicator of the species' spatial expansion processes. Within the framework of research activities focused on the distribution and abundance of meso- and large carnivores in Calabria, the Department of Biology, Ecology and Earth Sciences (DiBEST) of the University of Calabria collects occasional and opportunistic records of rare species and/or species of high conservation interest. For this purpose, road-kill events occurring within the regional territory are systematically recorded and catalogued. Between 2024 and 2025, five otter carcasses killed by vehicle collisions were reported to DiBEST on five separate occasions. All individuals were found along highly trafficked, high-speed roads. Three of the five records came from the lower stretch of the Crati River, an area where the presence of the species had not yet been adequately documented. In another case, the carcass was recovered near a watercourse adjacent to agricultural land, while the last record occurred in a highly anthropized area crossed by a small stream. The carcasses, belonging to both juvenile and adult individuals, were transferred to the Marine Zoology and Herpetology Laboratory of DiBEST for necropsy and further analyses aimed at supporting conservation and protection measures for the species. Opportunistic data, such as those derived from road-kill events, represent a highly valuable source of information on rare and elusive species like the European otter, particularly in complex and unevenly surveyed territories. The recovered carcasses allowed an update of the species' distribution in Calabria, confirming its presence both in previously unsurveyed areas and in sites formerly considered poorly suitable. The record from a highly anthropized context suggests that the occurrence of the species in human-modified environments may have been underestimated and deserves further targeted investigation. These findings point to the possible use of secondary hydrographic corridors and marginal habitats during dispersal and recolonization processes. At the same time, the high frequency of road mortality events in specific sectors highlights the urgent need to identify critical impact areas and to implement appropriate mitigation measures - such as wildlife underpasses, adaptation of hydraulic structures, and dedicated signage - which are essential to reduce collision risk, enhance ecological connectivity, and ensure the long-term conservation of the species.

N. 120

Quantifying fine-scale metrics of activity patterns using accelerometer data

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Activity patterns reflect interactions between endogenous circadian systems and behavioural plasticity that align sleep-wake timing with environmental conditions. However, most ecological studies rely on coarse metrics (e.g., diurnality / nocturnality), potentially overlooking fine-scale temporal adjustments used to cope with dynamic and human-altered timescapes.
We developed a framework to extract fine-scale chronobiological metrics. Using Euroboar data, we analysed accelerometer and GPS data from 171 wild boars (Sus scrofa) monitored across 20 study areas in 7 European countries. We identified activity bouts and quantified their duration and the onset relative to sunset. These traits were jointly analysed using a bivariate Bayesian mixed-effects framework to assess the effects of seasonality, environmental structure, and human pressures, accounting for individual- and site-level variation.
Activity timing and duration varied across seasons and environments, with risk-related disturbances such as hunting and wolf presence triggering earlier onset of activity. Moreover, this approach enabled the identification of distinct chronotypes in activity onset and duration, as well as a behavioural syndrome linking these traits, highlighting fine-scale temporal structure in activity patterns that extend well beyond traditional classifications of diurnality and nocturnality.
By explicitly modelling variation in both the timing and length of activity bouts, this framework of analysis captures a seldom-investigated aspect of temporal organisation in animals, giving new tools to understand complex and multifaceted behavioural patterns.

N. 121

Hares under focus: spatiotemporal overlap of mountain and brown hares monitored through camera trapping in an alpine area

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Ecological changes triggered by climate change are progressively shaping mountain animal communities, leading to novel assemblages and inter-species interactions. In the Alps, mountain hare (*Lepus timidus*) is currently experiencing a spatial retreat and demographic decline across its range. To assess potential altitudinal range shifts and spatial overlap with the more thermophilic brown hare (*Lepus europaeus*), camera trapping surveys have been implemented in the Adamello-Brenta Nature Park (Trentino, Central-Eastern Alps), within a project aiming at evaluating the extent of induced hybridization between the two species with potential adaptive consequences for *L. timidus*.
Camera traps (CT) were deployed in four areas of the park, between September 2022 and December 2024. The main survey was carried out implementing a grid-based sampling design within a biodiversity assessment. A total of 84 CT sites were monitored during the study period, distributed from 952 to 2084 m a.s.l. Photos and videos were screened manually by skilled operators to select lagomorph records. Species classification was based on morphological clues (head shape, ears and legs length, tail and coat colour). Individuals were recognized as either timidus or europaeus, as possible hybrids could not be easily diagnosed from their phenotype. Out of the total material recorded during the study, 2,821 records (2,535 photos and 286 videos) were attributed to the genus *Lepus*. In 831 records (29%) the species was identified with confidence, corresponding to 742 independent capture events: 445 (60%) were brown hares and 297 (40%) mountain hares. Gregariousness appeared to be similar for the two species (for both species only 5% of the records showed >1 individual).
Although the altitudinal distribution was significantly different between the two species (Wilcoxon test, $W = 22431$, $p<0.01$), a large altitudinal overlap was observed in the monitored range, due to the use of the entire range by the brown hare, as opposed to a skewed use towards higher elevations (>1700m) by the mountain hare. Elevation and snow presence positively influenced the occurrence of mountain hare, while no effect of temperature was detected (binomial GLM). Around 96% of the mountain hare records occurred in presence of snow (76% with a continuous coverage), whilst only they were 42% for the brown hare. Nonetheless, brown hares were observed at high elevations (>2000m) at very unfavourable conditions for a thermophilic species (freezing temperature and continuous snow on the ground).
Our results confirm the dependence of *Lepus timidus* on snowy conditions and a narrower altitudinal range that has been invaded by the brown hare, increasing the hybridization risk, as already observed in other Alpine areas. The integration of camera trap and non-invasive genetics data would provide a powerful framework to assess the species' response to environmental changes in alpine ecosystems.

N. 122

Beyond technical fixes: participatory approaches to livestock protection in a wolf recolonization area of the Italian Alps

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The natural recolonization of wolves in the Alps has intensified conflicts between biodiversity conservation objectives and traditional livestock farming systems. In South Tyrol (northern Italy), livestock protection measures (LPM) remain unevenly adopted despite increasing predation losses, indicating that technical solutions alone are insufficient. This study aimed to identify the main barriers to LPM implementation and to co-develop socially acceptable and feasible interventions by explicitly addressing the human and socio-economic dimensions of human–wildlife conflict.

Between 2022 and 2025, we implemented a structured, multi-step participatory process involving eight stakeholder groups: livestock farmers, public institutions, environmental organizations, hunters, tourism representatives, educators, animal welfare associations, and scientists. The process combined conflict mapping, a co-design workshop, and thematic working groups dedicated to refining and implementing short-term interventions. Stakeholder perceptions, attitudes, and the broader socio-economic context were explored through semi- structured interviews and integrated with evidence from previous studies conducted in the study area.

Stakeholders identified 25 key challenges and proposed 17 potential interventions. While technical and financial constraints were frequently mentioned, broader socio-economic factors—such as declining economic viability of summer pasture grazing, labor shortages, and structural changes in mountain farming—emerged as equally critical barriers to LPM adoption. Thirteen interventions were implemented during the project, including the professionalization of shepherding, targeted training programs, awareness and communication initiatives, and the development of collaborative governance mechanisms.

The results demonstrate that LPM adoption cannot be addressed in isolation from the wider social and economic context of mountain pastoral systems. Participatory processes foster dialogue, trust, and social learning among stakeholders, enhancing the social acceptability of wildlife management strategies. However, their long-term effectiveness depends on sustained institutional support and political commitment. These findings provide transferable insights for managing conflicts between humans and large mammals in socio-economically sensitive landscapes, in line with the session's focus on the human dimension of mammal conservation and management.

N. 123

Summer diet and potential foraging habitats of Barbastelle Bat (*Barbastella barbastellus*) in South Tyrol, Northern Italy

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The western barbastelle bat (*Barbastella barbastellus*) is a forest-dwelling species with a trophic niche strongly dominated by Lepidoptera. Given the pronounced habitat specialization exhibited by many moth species, this study infers bat foraging habitat use from the taxonomic and ecological composition of Lepidoptera prey identified through dietary analyses. *Barbastella barbastellus* mainly roosts in trees and forages in mature woodlands and along forest edges using low-intensity echolocation. In South Tyrol (Northern Italy), however, the species also uses buildings as maternity roosts, particularly the space behind window blinds of buildings at settlement edges. This behaviour suggests that the species may exploit different foraging habitats when living in human-modified Alpine landscapes.
This study investigates the summer diet of *B. barbastellus* maternity colonies, aiming to provide a first regional characterization of prey use and associated foraging habitats identified from dietary data. Faecal samples were collected from eight maternity colonies located in six municipalities across South Tyrol during summer 2024. Dietary composition was analysed using eDNA metabarcoding by amplifying the mitochondrial cytochrome c oxidase subunit I (COI) gene, enabling high-resolution identification of prey taxa and assessment of dietary diversity across colonies. Metabarcoding analyses revealed a highly diverse diet dominated by Lepidoptera, with more than 350 moth species identified, belonging to approximately 230 genera and 21 families. Most of the species detected belonged to the families *Noctuidae*, *Geometridae* *Crambidae* and *Pyralidae*. In addition to moths, the analyses detected prey from other insect orders including *Coleoptera*, *Diptera*, *Hemiptera*, *Neuroptera*, *Orthoptera* and *Blattodea*.
The dietary composition observed in this study suggests that *B. barbastellus* maternity colonies roosting at settlement edges exploit a taxonomically diverse prey assemblage during summer. Although Lepidoptera clearly dominates the diet, the consistent detection of additional insect orders indicates a relatively broad dietary niche. Our results further allow the identification and characterization of foraging habitats used by the barbastelle bat, based on the ecological and habitat requirements of moth species at both larval and adult stages in areas surrounding maternity colonies. Given that *Barbastella barbastellus* is strictly protected under the EU Habitats Directive and listed as Near Threatened on the IUCN Red List, the results of this study can inform the development and implementation of locally adapted, nature-based solutions and targeted conservation measures aimed at supporting the species within settlements, with particular emphasis on the maintenance and enhancement of functional connectivity corridors between maternity colonies and key foraging habitats.

N. 124

Estimating pack size and reproductive success in expanding wolf populations using camera trapping

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Estimating key demographic parameters of wolf (*Canis lupus*) populations, such as reproductive success, is challenging due to the species' elusive behaviour. Camera trapping represents a non-invasive monitoring technique capable of providing continuous, fine-scale information on both reproductive and behavioural dynamics over extended periods. Such data are essential for informing management strategies and for providing evidence-based information to local communities aimed at mitigating human-wolf conflicts.
This study was conducted in the Province of Pavia, where the species has been monitored since the late 1980s. Camera trapping was used to monitor resident wolf packs, with sampling sites arranged opportunistically based on prior knowledge of wolf movements (e.g., travel routes and marking sites) to maximise detection probability. Wolf presence was monitored continuously for one year, from March 2025 to February 2026, across 31 sampling sites distributed among the main habitat types of the study area: from the mountainous zones, where wolves have been steadily present for decades, to the lowland areas, where the recolonisation is more recent and still ongoing. To estimate the minimum number of packs and individuals per pack, camera-trap data were cross-referenced by considering the date and time of recordings, group size, the presence of phenotypically recognisable individuals, and the spatial distribution of detections. Once a sampling site was assigned to a specific pack, the maximum number of individuals recorded either simultaneously or, in the case of recognisable individuals, non-simultaneously was used as a conservative estimate of minimum pack size.
Over more than 5500 sampling days, almost 1000 wolf detection events were recorded and attributed to 15 distinct packs. Reproduction during the 2025 breeding season was documented in 13 packs. The mean post-reproductive pack size ($\pm$ SE) was 6.6 $\pm$ 0.6 individuals, and the mean number of pups per pack was 3.5 $\pm$ 0.6. In addition to established packs, 3 pairs were detected in the lowland, each occupying a stable territory for several consecutive months.
Our results confirm camera trapping as an effective and indispensable tool for estimating key demographic parameters, including pack size and reproductive success, in expanding wolf populations. Such information is critical for assessing population status and for planning adaptive management actions, which require accurate and up-to-date knowledge of species distribution and social structure.

N. 125

Updating knowledge on wolf (*Canis lupus*) feeding habits in Northern Italy: adaptation to emerging opportunities and alternative prey

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Diet is one of the most adaptable components of the wolf (*Canis lupus*) ecological niche, and, given the species rapid expansion across Italy and the context-dependent nature of trophic cascades, continued investigation of wolf feeding habits through long-term studies is essential to document responses to environmental change and emerging opportunities.
This study was conducted in the southern portion of the Lombardy region where wolves have been monitored since the late 1980s and in which wolves have recently expanded their range into the plain. Previous results on wolf diet in the Apennine sector of the area documented a shift characterised by increasing consumption of wild ungulates and a concurrent decrease in livestock, in line with broader European trends. Up to 2021, roe deer (*Capreolus capreolus*) and wild boar (*Sus scrofa*) were the main prey species, showing opposite temporal trends: wolf diet shifted from a predominance of wild boar (2007-2008 and 2011-2012) to an increasing dominance of roe deer from 2015 onwards.
The present work updates knowledge on wolf trophic ecology by incorporating data collected from 2022 onwards. Following the species expansion into lowland areas, the study area was extended to include the plains, focusing on areas of stable wolf presence where pack reproduction was confirmed. This expansion allows the evaluation of trophic patterns across contrasting landscapes and contributes with new insights into the adaptability of wolves in newly colonised environments.
In line with previous studies, wolf diet was assessed through scat analysis, with prey items identified from undigested remains. During the study period, a total of 787 wolf scats were collected (Apennine: n = 533; Plain: n = 254). In the Apennine sector, wild ungulates remained the dominant food category, although their overall contribution slightly declined between 2022 and 2025. Among ungulate species, wild boar represented the main prey in 2023 (MV% $\pm$ SE = 46.4 $\pm$ 3.4) and 2024 (44.9 $\pm$ 5.4), whereas cervids were most heavily consumed in 2021 (72.0 $\pm$ 2.7). Notably, in 2025, an additional prey species emerged as an important component: the coypu (*Myocastor coypus*), which became the third most consumed species alongside wild ungulates, with roe deer remaining the primary prey. In the plain sector, medium-sized mammals constituted the most important food category, followed by wild ungulates. Coypu dominated the diet of wolves in lowland areas, representing more than half of dietary biomass throughout the study period. Among large prey, wild boar was the most frequently consumed wild ungulate in 2021–2023 (11.5 $\pm$ 5.5), while roe deer increased in importance in subsequent years (2024: 13.8 $\pm$ 3.2; 2025: 26.0 $\pm$ 3.9).
Overall, our results highlight the high trophic adaptability of wolves, demonstrating their ability to exploit newly emerging opportunities. These include those potentially associated with African swine fever (ASF), which may have temporarily and locally increased the availability of debilitated or dead wild boar, as well as locally abundant alternative prey, such as coypu in lowland environments: a species that is easy to capture, can reach high densities, and provides a substantial biomass resource.

N. 126

Analysis of the distribution and climate niche shift of the raccoon (*Procyon lotor*) between its native and invaded ranges: the case of Tuscany

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Invasive alien species (IAS) are a major global threat to ecosystems, contributing significantly to biodiversity loss. The raccoon (*Procyon lotor*), an opportunistic mesopredator native to Central America, the United States, and southern Canada, was introduced to Tuscany following an accidental release from a local zoo near the Foreste Casentinesi National Park (PNFC). In Tuscany, the species has established stable populations, highlighting the need to assess its distribution and invasive potential. This study aimed to analyse the distribution and climatic niche characteristics of the raccoon in Tuscany, with the overall objective of understanding the ecological mechanisms regulating its spread and potential adaptation to new environments. Specifically, we aimed to: (i) assess the presence and distribution of the species in Tuscany; (ii) describe its bioclimatic niche in the native and non-native ranges; and (iii) compare the two niches to evaluate potential niche shifts during the invasion process.
Field monitoring was conducted in eastern Tuscany, including the PNFC. Because raccoons frequently use riparian habitats as movement corridors, sampling was stratified along the regional hydrographic network. The area was overlaid with a 2.5 × 2.5 km grid, and one random sampling point per cell was generated along rivers and streams. For each sampling point, occurrence data were collected through camera-trapping surveys within the PNFC, active since 2014, and extended outside the park between June 2024 and October 2025. Overall, 303 grid cells were explored, with camera trapping successfully implemented in 259 cells, resulting in approximately 5,608 trap-nights and a sampled area of 1,618.75 km². These data were integrated with verified additional records provided by PNFC staff and local authorities. Occurrence data from the native range were obtained from GBIF for North and Central America and filtered to retain georeferenced records limited to the time range 2014 - 2025 to match the non-native monitoring period. Climatic niche characterization was based on six bioclimatic variables derived from the WorldClim v2.1 database (resolution: 30 arc-seconds, ~1 km). Principal component analysis (PCA) and ordination-based approaches were used to describe and compare the climatic niches in the native and invaded ranges, quantify niche overlap using Schoener's D, test niche equivalency and similarity, and assess niche dynamics through centroid shifts and the calculation of niche stability, expansion, and unfilling indices.
A total of 178 raccoon occurrences were documented in Tuscany. The raccoon distribution showed a concentration of records in the central - northern part of the Province of Arezzo and several occurrences along the Arno River, supporting the role of river corridors in facilitating dispersal. Climatic niche analyses indicated that the Tuscan population occupies a restricted

portion of the native climatic space, characterized by milder, wetter, and less seasonal conditions. Niche overlap between native and invaded ranges was low (Schoener's D = 0.10), and both niche equivalency and similarity tests were rejected. High niche unfilling (0.88), together with complete niche stability and the absence of niche expansion, indicates that the raccoon population in Tuscany occupies a conserved but largely unsaturated climatic niche, consistent with an ongoing invasion process.
Overall, these results suggest that the raccoon in Tuscany may still be in an early stage of expansion, with potential for further spread. The study provides the most comprehensive assessment to date of raccoon distribution and climatic niche dynamics in Tuscany and highlights the importance of continued monitoring and targeted management actions, providing a foundation for assessing future range expansions in Italy and across Europe.

N. 127

Tracking an invasive squirrel from the canopy: arboreal selfie-traps and *Callosciurus finlaysonii*

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Invasive species pose a growing threat to biodiversity, as they can disrupt community structure, resource dynamics, and interactions among native species. The colonization of available ecological niches by non-native organisms underscores the need for effective monitoring tools to assess their distribution and ecological impact. This study focuses on *Callosciurus finlaysonii*, an invasive arboreal squirrel expanding in Italy, presenting its distribution within the Natura 2000 Site IT8050022 "Montagne di Casalbuono" and evaluating the effectiveness of an innovative arboreal camera- trapping "selfie-trap" approach for detecting invasive species.
The monitoring, developed within the R.A.MO.CA project "Roditori Arboricoli MOntagne di CAsalbuono", was conducted from April to September 2025 using 30 camera traps placed on wooden platforms installed directly to tree trunks at different heights (3–15 m), enabling sampling across the full vertical profile of the forest. Video recordings facilitated species identification and individual recognition based on morphological traits and pelage coloration, offering insights into population structure, including sex ratios. Presence/non-detection data were incorporated into occupancy models to simultaneously estimate site occupancy and detection probabilities, providing a robust representation of the species' spatial distribution.
Results indicate that *C. finlaysonii* is widely distributed across nearly all sampled cells, with high detection frequencies independent of forest type, reflecting substantial ecological plasticity and pronounced invasive potential. In addition, video analyses enabled differentiation of individual squirrels, confirming the protocol's ability to generate a representative sample of the population and to provide information on demographic composition.
Overall, the standardized arboreal "selfie-trap" camera-trapping protocol demonstrates methodological robustness, replicability, and statistical reliability for monitoring invasive arboreal species. This approach delivers detailed information on species presence, spatial distribution, and population structure, offering a valuable methodological framework for future ecological studies and management interventions, with potential applications to other invasive squirrels, such as the grey squirrel (*Sciurus carolinensis*), demonstrating its effectiveness in reliably detecting and monitoring dense, widely distributed populations.

N. 128

Protecting biodiversity: five years of mammal rescue at WildUmbria's Wildlife Rescue Centre

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Wildlife Rescue Centres (WRCs) are authorized facilities in which wild animals in distress, injured, or debilitated can be rescued, treated, and rehabilitated with the aim of reintroducing them into their natural environment. WRCs play a crucial role in the rescue and rehabilitation of Meso- and Large Mammals, which are often victims of road accidents, poaching, predation by domestic animals, or affected by infectious and parasitic diseases. WildUmbria has been operating as the Umbria Region's WRC since 2017, becoming over the years an important point of reference for the rescue of wild animals in the entire region. This poster highlights the activities of the rescue centre over the last five years (2021-2025), and the efforts made in the conservation of animal biodiversity with a focus on mammals and especially on the threatened species contained in the Habitats Directive.
The rescue operations carried out by WildUmbria saw significant numbers of animals rescued throughout the years, ranging from 1,266/1,334 in 2021 to 1,818/1,985 in 2025; with an average of 94.4 different species of vertebrates rescued. Among these classes, the two most frequently rescued are mammals and birds, that are rescued in almost equal proportions each year. Considering mammals alone, the number of animals recovered increased from 654 in 2021 to 835 in 2025, with an average of 20.2 different species over five years. The two species that consistently appear as the most rescued each year are the roe deer (with an average of 228.4 individuals rescued over five years) and the European hedgehog (with an average of 151.2 individuals recovered over five years). Among the Habitats Directive species that were rescued there are: the Apennine wolf, the European wildcat, the edible dormouse, the crested porcupine, the pine marten, the European polecat, and several species of bats. Bats are rescued in large numbers every year and among them some species of particular conservation relevance were rescued such as the European free-tailed bat, the brown long-eared bat, the grey long-eared bat, the noctule, and the Nathusius' pipistrelle.
The main causes of admission for the mammals included in Habitat Directive are: absence of parental cares (34.3%), traumatic injuries (31.6%), road traffic (17.1%), predation by dogs and cats (8.5%), entrapment (5.3%), infectious and parasitic diseases (2.9%), and poaching (0.3%).
The outcomes of the rescues are strictly dependent on the causes for which the animals needed to be rescued. Poached and trapped mammals were the one with the highest release rates of 100% and 86.2% respectively. A significant drop in release rates was observed in diseased animals that were cured and released in only 40% of cases, but positive outcomes were far worse for orphaned mammals (21%), for those affected by traumatic injuries (20.2%) or predated by domestic animals (13.2%). The mammals with the lowest success of rescue were the victims of road traffic, who were released only in 6.2% of cases, either because they died after the incident or because the damages were too severe and would not allow for survival in the wild.
It is to be noted that poached and trapped mammals are significantly less numerous than the other categories, hence the highest percentages of successful release. Besides, whilst poaching does have an impact on the mammal community, it is much more impactful on birds, especially

on raptors. On the other hand, mammals preyed upon by pets, and those involved in road accidents usually suffer much more serious injuries, resulting in longer hospital stays and greater efforts by operators and veterinarians that, unfortunately, are not always enough to rehabilitate and release the animals.
Wildlife Rescue Centers are therefore much more than simple „clinics“ for injured animals, they are neuralgic points of convergence for the care, conservation, and management of wildlife, and valuable tools for the protection of biodiversity. The data collected by WRCs are also useful to evaluate the presence of wildlife in human dominated environments and help the institutions to integrate good coexistence practices in order to mitigate the ever-increasing human-wildlife conflict.

N. 129

Many tools, many choices: a user-oriented overview of AI tools for camera trapping data

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Camera traps are one of the most relevant and widely used tools in wildlife ecology, that enable the non-invasive collection of large amounts of data across broad spatio-temporal scales and ecosystems. The extensive use of camera trapping has produced image volumes that exceed the capacity of manual annotation, creating a major bottleneck in the research workflow and calling for solutions capable of processing these data with reduced human intervention.
In recent years, different AI-based tools and platforms have emerged to streamline species identification and data management, potentially reducing processing time significantly. Yet, selecting the most appropriate tool can be a complex task for many users. Researchers often have specific requirements for data annotation to meet the study goals, the type of datasets, and other challenges such as computing resources and data policies. This poses trade-offs between automation, flexibility and data control. This work presents a user-oriented overview of different widely used tools and platforms that include AI-based procedures, such as Agouti, Wildlife Insights, DeepFaune and TRex. The aim is to examine the practical trade-offs of the different tools in order to offer valuable insights for choosing appropriate AI-assisted approaches in different data processing scenarios and on how these tools can be realistically integrated into monitoring and research programs.
We conducted a comparative assessment of selected tools based on criteria relevant to end users: (i) data-type requirements, such as pictures, videos and included metadata, (ii) workflow flexibility,
(iii) level of technical expertise required, (iv) suitability for different research objectives and (v) practical constraints related to infrastructure, internet connectivity and data ownership. The analysis was informed by official documentation, published use cases and study-case applications by the authors.
The reviewed tools differ in design and intended use. Wildlife Insights focuses on collaborative management of large-scale datasets, making it well suited for international or multi-project initiatives, but offers limited customisation. Agouti implements data standards (CamtrapDP) and secured data storage and ownership, but does not support automatic video processing. DeepFaune software represents a local, lightweight solution, enabling offline operations, but offers fewer features for data handling and for collaboration. TRex offers high flexibility and customisation potential but generally requires more advanced technical skills.
This overview highlights different trade-offs between automation, user control, model choice, scalability and implementation effort. Tool selection is highly context-dependent and should be guided by research goals, available resources (including users' expertise and manpower) and operational constraints. From a user's perspective, practical aspects such as ease of use, how results are presented and how data are handled throughout the workflow can be as influential as model reliability and performance. By adopting a pragmatic, user-oriented perspective, this overview aims to support researchers and data managers in making informed decisions when integrating AI tools into camera trap–based studies and data processing.

N. 130

Fine-scale urban ecosystems drive behavioural flexibility in red foxes

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Urbanisation may deeply alter ecological dynamics of wildlife populations, yet the role of fine-scale urban microclimates in shaping wildlife behaviour is still poorly understood. We investigated, for the first time using a mammal species, how Local Climate Zones (LCZs) influence the temporal activity patterns, behavioural strategies, and diet of red foxes *Vulpes vulpes* within the metropolitan area of Florence (central Italy).
We used camera-trap data collected at 22 locations, spaced 1 km apart, between 2023 and 2024 to quantify activity rhythms, behavioural budgets, and inter-zone temporal overlap. In addition, 862 fox scats were collected throughout the year along seven 1-km transects across the city of Florence, between 2021 and 2023, to assess dietary composition, as well as comparing it in the warm (April- September) and in the cold months (October-March).
Red foxes exhibited a remarkable spatiotemporal variability across LCZs, with activity peaks occurring at sunset in some areas and during the late night in others, reflecting variation in human disturbance, artificial illumination and local microclimatic conditions. Activity overlap among LCZs varied widely (37–95%), emphasising the diversity of behavioural strategies adopted across the urban landscape mosaic. Compared with a semi-natural site in central Italy, urban foxes were more vigilant and active, and spent less time resting and foraging. This suggests that urban environments are more unpredictable and require constant assessment of potential risks. A comparatively richer behavioural repertoire was shown in refuge areas in densely vegetated suburban LCZ. Throughout the year, and across semesters, the fox diet was heterogeneous, dominated by fruit in the cold months and by insects, particularly beetles and grasshoppers, in the warm ones. Even in urban ecosystems, insect consumption was high, although the relatively high proportion of anthropogenic waste in diet suggested an adaptation to anthropogenic food resources, especially within the city centre.
Overall, our findings showed that LCZs provide a robust framework for linking fine-scale microclimatic structure with fox behavioural responses to urban landscapes. Integrating LCZ-based approaches into urban planning could help human–wildlife coexistence by mitigating behavioural stress and promoting biodiversity in cities.

N. 131

Landscape and spatial correlates of vehicle collisions involving large and medium-sized mammals: a systematic review and meta-analysis

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Wildlife-vehicle collisions (WVCs), particularly those involving large and medium-sized mammals, represent one of the most widespread and consequential forms of human-wildlife interaction worldwide. These collisions result in human injuries and fatalities, substantial economic losses, direct wildlife mortality, and associated biodiversity loss. Understanding the drivers of mammal-vehicle collisions is therefore essential to mitigate their impacts on both human safety and wildlife conservation. Numerous studies have investigated a wide range of potential predictors influencing the frequency and spatial distribution of WVCs. Among these, landscape and spatial factors have frequently been identified as important correlates. However, findings remain fragmented across regions, species, and methodological approaches, limiting the identification of general patterns. Therefore, the aim of this study is to summarize current evidence on how landscape and spatial features influence WVCs.

To address this gap, in the context of the TransWILD Biodiversa+ project, we conducted a systematic review and meta-analysis following PRISMA guidelines. We applied a structured and replicable search strategy using Scopus, Web of Science Core Collection, BIOSIS Citation Index and Zoological Record databases, retrieving 2060 records and conducted title and abstract screening based on the following criteria: 1) presence of landscape and spatial predictors and 2) focus on terrestrial mammals. After the first screening, we retained 533 articles for full-text assessment and selected 185 for further evaluation on their suitability for the meta-analysis based on the presence of quantitative data.

Preliminary assessment of these studies involved extracting all reported landscape and spatial predictors to investigate their availability and comparability across studies for quantitative synthesis. Results show a high degree of heterogeneity among the predictors considered for the study of WVCs risk. In total, 172 distinct predictors were extracted from the selected studies. Six predictors related to land cover, water features, and traffic volume were considered in 30-40% of the studies, while 58 predictors appeared in only one study. This first classification of predictors provides the basis for determining which variables can be integrated in the meta-analysis.

This work aims to support evidence-based landscape planning and road mitigation strategies that enhance both biodiversity conservation and human safety, by providing a quantitative synthesis of landscape and spatial predictors of WVCs risk. We expect to identify which features increase or reduce collision risk across mammal species and contexts.

N. 132

Consanguineous pairing in Alpine Marmots: reproductive success and offspring survival

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The alpine marmot (*Marmota marmota*) is a highly social mammal that lives in family groups typically consisting of at least one pair of adult marmots (> 3 years old), i.e. a dominant female and a dominant male. These groups may also include a variable number of subordinate individuals belonging to three age classes: subadults (2–3 years), yearlings (1–2 years), and young (< 1 year). The species is highly territorial and exhibits a pronounced internal hierarchy, with the dominant pair monopolising reproduction and generally forcing subordinates either to disperse or to attempt a territory takeover. These dynamics contribute to the maintenance of genetic diversity, as family groups often include unrelated individuals, particularly in relation to the dominant pair.

In an ongoing research project, we monitored the composition and behaviour of seven marmot family groups from 2019 to 2025 in the Paneveggio - Pale di San Martino Natura Park (46°17‘ N, 11°46‘ E) in the eastern Italian Alps. Each spring, shortly after the emergence from hibernation, we carried out seven consecutive capture sessions using Tomahawk live traps. At first capture, each individual was sampled for biological material, underwent biometric measurements, was sexed and age-classified, and was marked with coloured ear tags and a microchip transponder for individual identification. During summer and autumn, we conducted systematic direct observation sessions to determine group composition and any demographic changes within each family group.

Between 2021 and 2025, we documented five cases of consanguinity with regard to the dominant pair in four distinct family groups. In four cases, the dominant pair consisted of same-aged siblings, while in one case the couple was composed of father and daughter. Offspring were recorded in four of the five consanguineous pairs, and in one case the young survived the hibernation period. In two additional cases of consanguineous reproduction observed in 2025, the young are currently hibernating. At present, three of the six family groups, currently occupying the study area, contain closely related dominant individuals.

Together with the most frequent social monogamy, social and genetic polyandry seems to be another optional reproductive strategy in the alpine marmot. Reproduction between consanguineous individuals has previously been documented in various parts of its distribution range, but seems to be mitigated by extra pair copulations (EPC), especially when sexually mature subordinate males are present in the family group. We report on preliminary results here, but we believe they are of particular interest, due to both (1) the extraordinarily high proportion of consanguineous reproductive pairs in our study area and (2) their occurrence almost exclusively in small family groups, i.e. with the exception of one case, composed only of the dominant pair and eventually their young. As a next step, we aim to determine, through genetic kinship analysis, whether the observed consanguineous pairs actually produced the offspring attributed to them, or whether these young resulted, at least in part, from EPC. Given that the alpine marmot exhibits one of the lowest levels of genetic variation known among mammals, the occurrence of consanguinity may be more widespread than previously assumed, especially in areas with low population density or a high degree of habitat fragmentation. Conversely, EPC may function as a mechanism to avoid both inbreeding and outbreeding depression, and may therefore contribute to the long-term survival of the species.

N. 133

Analysis of the Diversity and Distribution of Theriofauna in a Critical Area of the Central Apennines: the Salto-Cicolano District

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The Salto-Cicolano area (central Apennines) is a portion of territory of exceptional biogeographical importance, extending over 1,400 km² in a context lacking formal protection, despite the almost total absence of human activity and an area twice the size of the average Italian national park. Herein we present the preliminary results of a multi-year project (2025-2026) aimed at compiling a systematic checklist, analysing spatial distribution and finally estimating demographic parameters (relative abundance and density) of the local mammal communities. Our survey aims to fill the knowledge gap about this understudied non-protected area, identifying hotspots and species of conservation interest while collecting a baseline of data useful for the proper management of these territories.
During field research activities in 2025, over 60 daily missions were carried out, adopting different sampling protocols depending on the target species. Our main goal was to detect every mammal species within the study area. Using 30 camera traps, we investigated the spatial distribution of target species over a 10x10km sampling grid for meso and macro mammals and a 5x5 km grid for bats. Eight audiomoth devices were used and moved every two to three weeks to detect bats' presence, and three mist-net capture sessions were carried out. In addition, we placed approximately 100 hair tubes for small terrestrial and arboreal mammals. The methodology was supplemented by using Sherman and pitfall traps, analysis of bird wads, visual census of signs of presence (droppings, hair, footprints), validation of Citizen Science data and night transects using thermal imaging cameras. In addition, in coordination with the Lazio Region, we carried out a targeted monitoring to detect the presence of the Marsican brown bear.
The surveys produced over 2,000 fauna records, allowing for the reliable census of 45 species, among which the particular richness of bats stands out, with at least 17 certainly-identified species and a further 2-3 different taxa to be confirmed. Our results highlight the persistance of a very rich teriofaunal community characterised by a high degree of ecological integrity. In addition to defining the local distribution of species and identifying particularly rich areas, our work allowed us to estimate the density of elusive and threatened species, such as *Felis silvestris* and *Mustela putorius*, on which we are concentrating our camera trapping work aimed at estimating density, in a smaller study area, using REM and CTDS models. Moreover, we documented the presence of the Marsican brown bear within the study area, underscoring the importance of the area as a trophic-reproductive dispersal corridor essential for the expansion of the species' range outside its historical core area, validating the hypothesis of high functional connectivity of the landscape.
Our results suggest that the Salto-Cicolano area represents a biodiversity hotspot where plant and animal communities retain a structure and composition of considerable conservation value. The exceptional species richness found in this vast unprotected area highlights the need to implement conservation strategies beyond the administrative boundaries of existing parks. In conclusion, our study provides an essential knowledge base for planning in situ conservation actions, laying the foundations for proactive land management aimed at safeguarding ecological processes and the resilience of mammal populations in the Central Apennines.

N. 134

The Prey Avoidance Game: Temporal Partitioning Among Roe Deer, Wolves, and Humans

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As wolves (*Canis lupus*) recolonize the Alps after a long period of extirpation, it is important to understand the ability of prey populations to respond to this renewed predation pressure. Investigating the response of prey to the recolonization of wolves is particularly important in human-dominated landscapes, where prey must now balance exposure to risks from humans and natural predators. One way prey can respond is by adjusting their diel activity to reduce overlap with predators and humans. Understanding the ability of prey to adjust their diel activity in response to the presence of natural predators and humans is crucial for assessing the capacity of prey to respond to the recolonization of wolves and other large carnivores across their historic ranges in Europe.

To better understand how prey balance exposure to risk from humans and natural predators by altering their diel activity patterns, we established a camera-trap network to monitor the activity patterns of roe deer (*Capreolus capreolus*), wolves, and humans in the Cembra Valley, Trentino, Italy, where wolves recolonized the area in spring 2022. In January 2025, we deployed 30 camera traps across a 15 km² grid network within a mountainous, forested landscape. The network was divided into 1 km² grid cells, each with a randomly selected location where two cameras were placed at the closest road or trail to maximize wolf detections. Each camera trap was programmed to record a 5-second video upon motion detection. Monitoring has been continuous since deployment.

We modelled the diel activity of roe deer as a function of the risk from human hunters, recreationists, natural predators, and other control variables using a multinomial logistic regression. Roe deer activity patterns were more strongly influenced by human activity than wolf presence, with roe deer increasing their crepuscular and nocturnal activity regardless of wolf risk. This effect was further amplified during the hunting season, when lethal risk from humans was elevated.

The results show that the activity patterns of roe deer seem to be more influenced by the presence of a super-predator (humans) than by the predator (wolves). These findings appear to be consistent with other recent research, which has observed that in a context where both predators and super-predators are present, prey tend to respond more to the presence of the latter. This does not exclude the possibility of other types of behavioral adaptation on the part of the prey in response to the predator, such as a shift in home ranges to areas considered safer or an adjustment in the use of specific sites of interest such as supplemental feeding sites.

N. 135

Harnessing Artificial Intelligence for small mammals monitoring through non- invasive trapping

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Small mammals make up over 50% of mammalian diversity, with rodents alone accounting for 46%: they play crucial roles in ecosystems and include many invasive species of conservation concern that require constant monitoring. Despite their ecological and conservation importance, monitoring small mammals proves challenging: live-trapping is labour-intensive, costly in terms of resources and expertise, and often leads to animal mortality. As such, less invasive approaches such as hairs collection through hair tubes and animal tracking via footprint traps represent useful alternatives, particularly valuable for long-term studies and for detecting rare and elusive species. While effective, however, the identification process of species-specific hair structures and footprints is time- consuming and demands specialized skills, making it inaccessible to most researchers and conservationists. To bridge this gap, we propose an artificial intelligence-based solution for automated small mammals species classification, comprising two modules: HAIRS (Hairs Artificial Intelligence Recognition Systems) and PAIRS (Prints Artificial Intelligence Recognition Systems).
We obtained hair samples from private and museum collections for ~20 small mammal species that are commonly found in Italy. For each species we sampled at least three individuals and collected 10 dorsal guard hairs per individual. Hairs were mounted on microscope slides following standard protocols and photographed along their full length so that both the cuticle (outermost layer showing species-specific scale patterns) and the medulla (central core whose cell structure vary among taxa) were visible. We then trained and fine-tuned a Convolutional Neural Network (CNN) using transfer learning from the ResNet50-V2 architecture to classify species from both cuticle and medulla images. Footprint data came from a national monitoring program that used ink-imbued tracking tunnels with white paper strips to collect paw impressions of small mammal species. Strips were photographed following a standardized protocol; we then organized photographs to the highest reliable taxonomic resolution (species or genus where species-level assignment was ambiguous), retaining only crops where single species footprints were clearly identifiable. Finally, we trained a CNN following the same procedure described above, to classify species from footprint images.
Preliminary results indicate promising capabilities of our pipeline in automating small mammal species classification from hair and footprint samples. A prototype of the HAIRS algorithm trained on a subset of species of interests (*Apodemus flavicollis*, *A. sylvaticus*, *Glis glis*, *Microtus savii*, *Muscardinus avellanarius*, *Sciurus vulgaris*) achieved testing classification accuracies of 95.3% for the cuticle and 96.2% for the medulla, showing good discrimination between species that are commonly hard to distinguish following traditional methods (for example, *A. flavicollis* and *A. sylvaticus* were both classified with accuracy >95% for the medulla). The PAIRS algorithm as well

showed very promising, with testing classification accuracies reaching 90% on a sample of selected taxa (*Apodemus spp.*, *Eliomys quercinus*, *G. glis. M. avellanarius*).
A working demo of our algorithms will be soon made freely accessible as a web-based Gradio application, which will enable practitioners to run them on an easy-to-navigate graphical interface. Additionally, our HAIRS and PAIRS prototypes are being progressively expanded to include the full suite of species for which we hold samples, and the model architecture and training workflow are easily scalable to incorporate additional taxa and geographic regions in the future. Our proposed pipeline will deliver a fast, non-invasive, and reproducible tool for large-scale monitoring of small mammals, reducing dependence on labour-intensive live trapping, enabling long-term deployments, and with clear applications in the conservation and management of small mammals.

N. 136

Survey area extent biases density estimates differently across methods in terrestrial mammals

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Populations density is a critical piece of information in wildlife ecology, management and conservation: it enables assessment of spatial and temporal variation and informs evaluations of conservation status and extinction risk. Reliable density estimates are, however, costly to obtain and typically require extensive field sampling. Past studies have shown a positive relationship between survey area extent and the reliability of density estimates, suggesting that larger sampling extents reduce biases arising from edge effects and home-range truncation. Nevertheless, funding and logistical constraints force researchers to carefully balance the resources allocated to population surveys: sampling extent must be large enough to faithfully represent the population of interest, while keeping survey costs manageable. To address this trade-off, we quantified biases in estimated density at varying levels of survey area extent, focusing on three popular density estimation methods for medium-to-large mammals: Capture-Recapture (CR), Spatially-Explicit Capture-Recapture (SECR), and Random Encounter Model (REM).

We gathered 2'733 global population density estimates for 145 mammal species from the TetraDENSITY 2.0 database reporting survey area. For each density record, we estimated the home- range size for the corresponding species, and we quantified the Relative Spatial Effort (RSE) as the ratio between the sampled area and target species home-range extent. Then, we modelled intra- specific variations in density in response to the RSE through a Generalized Additive Mixed-effects Model, while controlling for biological traits, environmental and anthropogenic drivers that can shape density patterns across space. Further, to truly isolate the effect of RSE from other confounding factors, we also simulated the process of density estimation following the three methods (CR, SECR and REM) across a wide range of target species in terms of movement type, population density, and sampling design scenarios. We simulated 10'000 virtual populations for which we estimated density across a wide range of RSE, and used a Random Forest algorithm to unveil parameters importance and contribution in determining biases in estimated density across the three methods and survey designs.

Our results clearly identified a differential effect of survey area extent on population density across the three methods: CR exhibited a clear negative relationship with RSE, indicating that small survey areas in relation to the target species space-use requirements lead to overestimation of density. SECR showed a similar but less pronounced trend, whereas REM model showed no response to the RSE. Our simulations results corroborate these patterns, suggesting that with CR, sampling an area smaller than 10 times the target species home-range size can overestimate density up to 300%. In SECR, matching the target species home-range size is required to reduce bias at minimum. In contrast, REM estimates are unaffected by the extent of survey area.

Our findings have direct implications for survey design and methodological choices: sampled area relative to species space-use is a strong, interpretable predictor of systematic bias in widely used density estimators. We provide concrete, quantitative guidance on minimum spatial effort requirements for three commonly applied methods, showing that insufficient survey extent can lead to severe overestimation of population density. Our results offer a practical benchmark to anticipate bias, compare studies, and justify methodological choices under logistical constraints, while highlighting REM as the most robust alternative when large spatial coverage is infeasible. These results represent a critical step towards more reliable population assessments to support effective wildlife management and evidence-based conservation decisions.

N. 137

Rodent foraging behaviour in a Landscape of Fear: analysis of antipredator responses in forest habitats

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Rodents are a major trophic resource for numerous predators and thus experience persistent predation risk. The trade-off between food acquisition and predator avoidance strongly shapes rodent behaviour and is commonly examined within the Landscape of Fear framework, which describes how animals perceive and respond to spatial variation in predation risk. This framework identifies three main antipredator strategies: avoidance of high-risk areas, shifts in diel activity patterns, and behavioural adjustments that reduce predation risk. The first two strategies influence habitat selection by shaping foraging- site choice. Personality (i.e., consistent individual behavioural differences) is closely linked to risk perception and foraging activity and can mediate foraging behaviour both directly and indirectly through foraging-site selection. Rodents primarily base foraging-site choice on microhabitat structure, preferring dense vegetation that provides shelter and escape routes; consequently, personality-driven differences constitute an important source of variation in foraging behaviour under predation risk. Nevertheless, temporal shifts in activity patterns appear to be the dominant antipredator strategy among mammals in our study area, as prey tend to avoid periods of peak predator activity. Despite extensive research, how personality influences risk perception and foraging behaviour in rodents remains poorly understood, particularly in habitats with reduced natural refuges and understory cover, such as coppice forests. Moreover, it remains unclear whether rodents also mitigate predation risk by adjusting activity periods to reduce temporal overlap with their predators. To address these knowledge gaps, we analysed rodent foraging-site selection across forest habitats differing in the availability of safe sites, including fully exposed habitats, and compared the activity patterns of mice and voles with those of their avian and terrestrial predators, incorporating individual personality profiles based on highly repeatable traits. Experiments were conducted in the Prealpi Giulie Natural Park (northeastern Italy) between May and October 2024 and 2025, encompassing 21,600 trap-nights, as part of a capture–mark–recapture study. Rodent personality was measured in 119 *Apodemus flavicollis* and 97 *Clethrionomys glareolus* using standardized open-field, emergence, and handling tests. Rodent activity patterns and foraging site selection was assessed through a cafeteria-style experiment that measured 1920 rodent–seed interactions with infrared cameras and RFID readers. To assess the presence and activity patterns of small mammal predators, particularly nocturnal raptors, we relied on passive acoustic recording units (ARUs) and BirdNet classifier algorithm alongside; we also deployed 18 trail cameras evenly divided within our small mammals trapping grids to evaluate the presence and abundance of mammalian predators. Lastly, to examine potential differences in habitat perception with respect to predation risk, we measured microhabitat structure at each trapping location. Our results highlight the most important factors shaping how terrestrial rodents cope with predation risk. We observed a significant mismatch between the activity period of rodents and Tawny Owl (*Strix aluco*), while personality did not influence diel activity patterns. We also report results on foraging site selection, identifying factors that may influence perceived safety and site choice in terrestrial rodents. Our findings reveal how rodents adjust their activity through multiple antipredator responses. They respond to predation risk not only by selecting safer foraging sites, but also through a systematic avoidance of temporal overlap with predators, which occurs independently of individual traits. This underscores the importance of considering multiple cues of predation risk to better understand rodents' foraging behaviour in forest habitats.

N. 138

Wolves rescue in Italy

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The wolf is a protected species classified as vulnerable by the IUCN Red List of Italy and a key element of natural ecosystems. Its progressive recolonization of the Mediterranean areas led to an increasing conflict between wolves and humans, and consequently to a rise in the numbers of individuals reported to Wildlife Rescue Centers, which take care of injured animals and possibly release them back into the wild. Rescue Centers can contribute to the maintenance of healthy and viable wild populations, often threatened by human activities, but quality rescuing procedures are crucial for effective rehabilitation. Despite the important role of the Wildlife Rescue Centers, there is no national legislation that regulates them, nor is there a standardized protocol for wolf rescues.
In 2021, we contacted regional authorities to identify all Wildlife Rescue Centers licensed to rescue wolves in Italy. Afterwards, between 2021 and 2022, individual Centers were contacted and interviewed, following the outline of a questionnaire, to evaluate the different procedures used to heal, rehabilitate, and eventually release injured wolves. When possible, information on individual rescues was collected.
Regional authorities indicated a total of 27 Centers, of which 19 were interviewed. Most of these facilities were run by volunteers and relied on donations. The wolf rescue protocols followed by the Centers were not uniform, with experience-based assessments often preferred over a systematic approach with standardized criteria. The ethological aspects were reported as scarcely considered, both during daily care and at pre-release suitability assessments. Practices to prevent habituation to humans are often limited or heterogeneous. Less than a fourth of the Centers regularly equip animals with radio collars upon release, with post-release monitoring rarely possible due to a lack of funding. Regarding individual cases, a total of 206 wolves were rescued at the time of the interviews. Human activities were the main cause of intervention, with road collisions and poaching being the first two rescue causes, covering almost three-quarters of the cases. Less than half of the rescued wolves were released back into the wild, and little information was collected after the release.
Human activities are one of the main threats to wolf populations. The work of Wildlife Rescue Centers can help mitigate the conflict, but the application of sound practices is essential. This research highlights the need to develop a standardized and effective wolf rescue protocol, focused on both the physical and behavioural rehabilitation of the subjects. A systematic post-release monitoring program is also essential to assess the true effectiveness of rescue procedures. We encourage collaboration between Centers, authorities and the scientific community to develop such protocols and promote scientifically driven rescues and reintroductions of this charismatic species.

N. 139

Habitat-based proxies for insect abundance as predictors of bat feeding activity at wind turbines

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Wind turbine installation is accelerating worldwide as countries expand their renewable energy infrastructure. As this happens, understanding the impact of wind turbines on bat populations is crucial for balancing green energy with wildlife conservation. Acoustic monitoring of bat activity is the most used method for assessing species presence and relative activity levels before and after wind farm construction. Yet, bat behaviour is rarely incorporated into risk assessments. Bats often feed near turbines, flying erratically, attracted by insect-rich areas. This study explores whether habitat features presumably linked to high insect abundance can reliably predict bat feeding activity at wind turbines.
We monitored 51 turbines across 10 wind farms in southwestern Norway in 2024-2025, using ultrasonic detectors to record bat presence and behaviour. All acoustic data was manually validated to determine species (or species group) and identify foraging behaviour (feeding buzzes). Habitat variables that are positively correlated with insect abundance – like vegetation productivity (NDVI), forest and freshwater cover and vegetation height– were extracted and mapped as proxies of insect abundance. Additionally, as the sun warms up south-facing hillsides creating vertical air currents, we also identified and quantified air uplift zones by combining terrain ruggedness index, steepness and cardinal direction of the slopes. We then used a custom hierarchical Bayesian occupancy model to understand how habitat affects bat feeding activity across seasons, and whether these patterns vary for residents compared to migratory species.
Preliminary results on the influence of habitat variables on feeding activity showed strong positive effects of the air uplift index, especially in interaction with other habitat variables.
In particular, air uplifts together with vegetation productivity (NDVI) and forest cover showed positive effects on *Eptesicus nilssonii* feeding activity. Freshwater cover around turbines was positively correlated with *Pipistrellus pygmaeus* feeding activity. Data from 2025 are now being added to the analysis alongside newly developed habitat variables based on remote-sensing data.
We found that habitat variables like vegetation cover, freshwater and the innovative air uplift index, predict foraging behaviour in wind parks. These results aim to help predict sites with elevated feeding activity, and thus of potential high risk of collision, allowing targeted mitigation strategies within a wind park project area.

N. 140

Acoustic occurrence of cetaceans in northern Sicily: first passive monitoring insights from the Gulf of Palermo and Ustica Island

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Passive acoustic monitoring (PAM) is a key non-invasive tool for detecting vocal marine mammals and assessing their occurrence and spatial distribution. Despite its increasing application across the Mediterranean, species-specific acoustic data remain scarce along the northern coast of Sicily. To address this gap, Avvistiamo APS implemented the first PAM programme in the Gulf of Palermo and around Ustica Island (67 km northwest of Palermo), integrating acoustic data with simultaneous visual observations. Monitoring was conducted using a static Aquarian H2D hydrophone connected to a Zoom F3 recorder along linear transects, enabling direct comparison between acoustic detections and visual confirmations. Sampling occurred between 10 May and 20 November 2025, covering late spring to early winter. A total of 221 recordings were collected (12 h 45 min of acoustic effort; mean duration 03:27 min). Species identification was performed through visual inspection of spectrograms using Raven Lite 2.0. Of 72 positive detections (5 h 41 min), 34 were attributed to striped dolphins (*Stenella coeruleoalba*), 2 to common dolphins (*Delphinus delphis*), and 28 to bottlenose dolphins (*Tursiops truncatus*). Six recordings contained simultaneous vocalisations of Ziphius cavirostris and T. truncatus, indicating multispecies acoustic presence. Mean seafloor depth at detection locations was approximately 572 m for *S. coeruleoalba*, 332 m for *T. truncatus*, 774 m for *Z. cavirostris*, and 190 m for *D. delphis*. These values provide spatial context but must be interpreted considering the variable detection range of the Aquarian H2D, influenced by source levels, environmental conditions, and ambient noise. Nearly all detections were visually confirmed, except for *Z. cavirostris*, acoustically recorded for the first time in the study area. These results provide the first acoustic baseline for the region and demonstrate the value of combining PAM and visual surveys for cetacean monitoring and conservation.

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